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KOREA'S CHERISHED ASTRONOMICAL CHART.

W. CARL RUFUS.

A university professor recently asked, "Where is Korea?" Perhaps a photograph and a short description of one of the astronomical treasures of this obscure country may be of interest.

Like other Orientals the Koreans gave considerable attention to astrology and astronomy at a very early date. Keui-ja, the reputed founder of Korean civilization 1122 B.C., guided, or at least influenced, by the reigning constellation, sailed up the Tai-tong river, established his capital at Pyeng Yang and gave his nine laws to the land. During the succeeding centuries physical phenomena have ordered the course of human events. Ancient Silla once was saved by a meteor that fell in the camp of the enemy foretelling destruction. In 1235 the king turned sun-worshiper to obtain peace for the land. Pyeng Yang was prevented from becoming the modern capital by an unpropitious hail storm. During the seventeenth century the army was ordered out upon the appearance of two comets presaging war. Eclipses, earthquakes, fighting clouds, showers of various articles, thunder in winter, two suns in a day, black spots in the sun, and a white bow in the sun, have also contributed to Korean history. Temples are erected for the worship of heaven, the earth and the seven stars; spirit houses are dedicated to the color gods of the five divisions of the sky, to the constellations and the stars. There are also forms of moon worship; men pray to the Pleiades, bow to Venus, and the emperor as late as 1900 sacrificed for rain. The almanac for the current year in daily use, by employing various astrological cycles, indicates numerous combinations propitious or unpropitious for marriages, funerals, journeys, business ventures and other affairs of life.

In the government museum, Chang-duk Palace, Seoul, are displayed specimens of old astronomical apparatus, including an armillary sphere, a clepshydra, an old iron clock-frame, a marble gnomic plane, an oblique sun-dial, a moon-dial or month measure, a brass astrolabe and stellar planisphere of the northern hemisphere, a nameless pear-shaped instrument in a small case, and two stone models of our subject bear-

ing the date, December, 1395. The older stone shows marks of transportation and erosion, rendering the inscription partly illegible. The newer stone is an excellent piece of white marble, well preserved; the dimensions are 6′ 11″ x 3′ 3″ x 1′ 0″, and approximate weight 3975 pounds.

The old engraving was made by order of King Yi Tai-jo, founder of the last Korean dynasty, and was patterned after a rubbing of a more ancient stone, that was previously kept in Pyeng Yang, but was sunk in the river and lost when Ko-gu-ryu fell in 672 A. D. Some of the tables were revised, but no changes were made in the central astral chart, which follows the astrography of the ancient Chows of China, with the addition of the zodiacal divisions and adjustment of the equinoxes made by the Hans about the time of Hipparchus. The planisphere of 1395, like its royal owners, suffered a checkered career. Transferred from one palace to another, it shared the fortune or the fate of the imperial house. Now, magnificent new buildings erected for its protection were graced by its presence; again, it lay in the ruins of the old. Having grown prematurely old and grey, it was succeeded about the beginning of the eighteenth century by a new model engraved in white marble with no modification of the contents. Forsaken at first it was afterward placed by the side of its beautiful counterpart to witness together the departing glory of the house of Yi. To-day they lie degraded in the open, unfloored portico at the back of the central building of the government museum, near the site of their former abode, which was torn down when the Japanese transformed the former palace grounds into the present institution.

The subject matter of the chart consists of the central astral map, a table of the twelve zodiacal divisions, a circular chart of the constellations culminating at dark and dawn for the 24 solar periods, short treatises on the sun, the moon and the heavens, a table of the 28 zodiacal constellations or lunar mansions, and a history of the chart. Selected parts of the translation of its contents follow.

THE SUN.

The sun is the essence of the great positive element and the head of all the positive creation. It travels 24 degrees on both sides of the equator (red road). When the sun is distant it is cold, when near it is hot, and when midway it is mild. The positive element operates thus: the sun proceeds north, the days are long and nights short, and because the positive prevails it becomes warm and then hot. The negative works in this way: the sun retires to the south, the days are short and nights long, and because the negative prevails it becomes cool and then cold. If the sun travels south or north the degrees change, when it proceeds and remains at a long distance it is cold all the time, when it returns and remains at a short distance it is warm all the time. So it directs the beneficent power of life and

growth. Being the symbol of sovereignty, when it traverses the countries possessing knowledge, the days are bright and glorious. Then the king flourishes in prosperity and the people dwell in peace.

The stars are the glory of the positive essence. The positive element produced the sun, the sun divided and formed the stars; so the character for "star" consists of the character "sun" with "beget" underneath. It is said that the stars scattered (explosively) and spreading out dotted the heavens.

THE MOON.

The moon is the essence of the great negative element and the head of the whole negative creation. So it is the sun's mate, the symbol of the queen; and comparing with virtue it has the meaning of punishment. It also typifies all the feudal kings and ministers of the court. When it travels east of the ecliptic (yellow road), it is called the azure road; south of the ecliptic, the red road; west, the white road; north, the black road. The four roads, both on the inside and outside of the ecliptic, together with the ecliptic, make the nine roads.

Ecliptic and equator:—The road in which the sun dwells is called the ecliptic; and the one midway between the north and south poles, where the degrees are equal, is called the equator. The ecliptic is half outside and half inside of the equator. In the east they intersect a little preceding the fifth degree of Horn, and in the west a little beyond the fifteenth degree of Astride. (These constellations contain respectively Spica and Mirach.)

DISCUSSION OF THE HEAVENS.

In the Ch'in Chi the scholars of old say that the form of heaven and earth resembles an egg; the heavens on the outside enclose the earth, like a shell with the yolk inside. The surrounding part revolves without end. Because the form was utterly chaotic it is called chaos-theory heaven. During the Ch'in dynasty, Kal Hong said that the circumference of the heavens is $365\frac{1}{4}$ degrees; half covers the earth overhead and half surrounds the earth underneath, so half of the 28 constellations are visible and half invisible as the heavens revolve like a wheel At the time of the Song dynasty Ha Sung Chun examined the chaos-theory globe and investigated the theories of the heavens, whereupon he perceived that the heaven is truly round and half of it is water, also that the middle of the earth is high, the outside is lower and water surrounds the lower part. Also at the time of the Yang dynasty Cho Whon said that the shape of the chaos-theory heaven inside is round like a ball. In general in the discussions among astronomers there were six theories. (The others are here enumerated.) All the subsequent theories seem unreasonable, surpassing credulity; at least the ancient scholars did not esteem them of much value.

HISTORY OF THE CHART.

The lost model stone of the above astronomical chart was kept in Pyeng Yang, but on account of the disturbance of war it was sunk in the river; many years having passed since it was lost existing rubbings of the original were also out of stock. However, when His Majesty began to reign, a man having one of the originals tendered it to him. His Majesty prized it very highly and ordered the court astronomers to engrave it anew on a stone model. The astronomers replied

that the chart was very old and the degrees of the stars were already antiquated; so it was necessary to revise it by determining the present midpoints of the four seasons and the culminations at dark and dawn, and to engrave an entire new chart designed for the future. His majesty responded, "Let it be so." They spent the time until the sixth moon of 1395 preparing the new list of meridian stars. On the old chart at the beginning of spring Pleiades culminated at dark, but now Aries does. Consequently, the 24 solar divisions were changed in succession to correspond with the meridian stars of the old chart. The stone was carved and just now completed.

Thereupon His Majesty commanded me, his obedient servant, Keun, to make a record to follow the other part. His humble servant, Keun, calling to mind that from ancient times the emperors have not neglected the worship of heaven and the directors, and have made it their first duty to arrange a calendar, the celestial signs and sacrificial seasons, as Emperor Yao commanded Hi and Ha to set in order the four seasons, and Emperor Soon had the turning sphere and transverse tube and put in order the seven directors, faithfully worshiped heaven and diligently served his people, so I respectfully think that these duties are not to be neglected. His wise beneficent, martial, Imperial Majesty ascended the throne upon the abdication of his predecessor and throughout the whole country brought peace and prosperity, comparable with the virtuous achievements of the Emperors Yao and Soon. He gave great official attention to astronomy, revising the midseasons and stars, even the directors of Yao and Soon. In this way, I believe, by observing the heavenly bodies and making astronomical instruments he sought to find out the mind of Yao and Soon and to emulate their most worthy example. His Majesty exemplified this pattern to the hearts of all; upward by observing the heavens and seasons, downward by diligently serving the people. So through his spiritual achievements and prosperous zeal, he also, together with the two emperors, stands highly exalted. Moreover, he had this chart engraved on pure marble to be an eternal treasure for his descendents for ten thousand generations.

All ye who read, believe!

Hong Mu, 28th year, 12th month. (December, 1395.)

The chart summarizes the orthodox teaching concerning the sun, the moon and the starry heavens. The sun is the astronomical great father and the moon is the astronomical great mother; or, to carry out the simile of the chart, they are the king and queen of the universe. In Confucian cosmogony the sun is the concreted essence of the positive or masculine principle in nature, and the moon of the negative or feminine principle. These two primary essences were evolved from the Great Absolute, the *primum ovum* of the physical universe and philosophical ultimate of the Confucianist. The positive category includes the sun, stars, thunder, lightning and the rainbow; the negative includes the moon, rain, dew, frost, snow, fog and mist. The attributes of the positive element are heat and light, life-giving properties; of the negative are cold, darkness and dampness. Annual observation of the changes in the sun's position and accompanying changes in the seasons and vegetation led to the common belief of the ancients

that the sun possesses life-giving power. Quite naturally to these beneficial physical properties moral virtues were added, so the King of Day is not an arbitrary cosmocrat, but the beneficent ruler of the universe, a symbol of kind and benevolent sovereignty upon the earth. As the negative element is the complement of the positive, so its concreted essence, the moon, is the Queen of Creation, and the symbol of the king's consorts and court assemblage. The original idea of complementary relationship for perfect unity contained the idea of contrast or oppositeness, not necessarily antagonism, e.g., light and darkness, heat and cold, heaven and earth, water and land, husband and wife. Unfortunately for the moon and for womankind the contrast was carried into the moral realm, so the moon stands for destructive or punitive qualities, and the idea of woman is associated with all kinds of evil, accounting in a large measure for her low social positon.

The central astral chart is projected on the plane of the celestial equator and contains all the constellations at any time visible in Korea. The left is east; top, north; right, west; and bottom, south. The north pole is the center and three concentric circumferences mark the circle of perpetual apparition at about 38 degrees from the pole, the celestial equator, and the boundary of the circle of perpetual occultation at about 55 degrees south declination. The ecliptic is represented with a fair degree of accuracy. The River of Heaven (Milky Way) is given due prominence. Radial lines corresponding to the 28 zodiacal constellations divide the map into as many parts in addition to the inner circle. These divisions grouped by sevens form four unequal quadrants, concerning which the inscription says: "In each of the four directions the seven constellations make a single shape. In the east they form a dragon, in the west a tiger, both having the head south and the tail north. In the south they form a bird, in the north a tortoise, both having the head west and tail east." This division into quadrants is entirely arbitrary and the assignment of the animals purely imaginary. The azure dragon, however, suggests a resemblance to that mythical animal, rivaling the imagination of the Greeks and the Romans.

The celestial mythology is fascinating. The heavens are peopled with gods and goddesses, "a celestial galaxy for terrestrial adoration." The dragon guards the mansion of the gods lest they fall. In the central division are palaces and thrones, where dwell the Great Celestial Emperor (Polaris), the royal family, ministers, servants, and feudal kings; also the royal stables and palace for women. Comets sweep the celestial courts and shooting stars are the refuse thrown out of heaven. In Ursa Major reside the fates presiding over the destiny of mankind. In the southeast are the pillars of heaven and celestial portals. In the north-east separated by the river of heaven are found the star lovers,

the Herdsman and the Trysting Maiden. Farther north are the seats of twelve ancient feudal states; to the west of which the gods of Thunder bellow and Prince Lightning flashes forth. In the west rides "Astride," the star of literature, pictured with a pencil in his hand. Near by are the gods of the clouds and the rain, distilling the essence of heaven for the thirsty earth. The brilliant south contains the Wolf Star (Sirius); also the Old Man Star (Canopus), which the Koreans believed could be seen only from Quelpart and the sight of which insured a happy old age. Spanning the heavens like a triumphal arch is the beautiful Galaxy, which the *poetic* West styles the Milky Way, and the *prosaic* East calls the Silver River of Heaven.

The star configurations are very old. An astral chart of the Chow dynasty, about 600 B. C., a copy of which is in the Royal Library of Paris*, contains 1460 stars. On the Korean chart we find a total of 1463 stars under 306 designations, showing practical agreement with the standard astrography of the Chows. Comparing with other ancient authorities we note that the catalogue of Hipparchus, second century B. C., contained 1080; Pliny, first century A. D., whose scientific merit is questionable, reckoned 1600; Ptolemy, second century A. D., a very careful investigator, records 1028. Young says,† "The total number which could be seen by the ancient astronomers well enough to be observable with their instruments is not quite eleven hundred." But here we find 1460 stars "correctly laid down," to use Allen's expression, 400 years before the time of Hipparchus. Many of the asterisms, especially among the zodiacal constellations, are much older and their origin is probably Euphratean.

* Allen, Star Names and Their Meanings, p. 21.

† Manual of Astronomy, p. 478.

A DETERMINATION OF LATITUDE, AZIMUTH, AND THE LENGTH OF THE DAY INDEPENDENT OF ASTRONOMICAL OBSERVATIONS.

ARTHUR H. COMPTON.

It has long been possible, with apparatus such as the Foucault pendulum, to measure the component of the earth's component about a vertical axis, and by observations on freely falling bodies, or better still by watching the descent of the weight of an Atwood's machine,* the horizontal components of the earth's rotation may be determined. If the latitude at which the observations are taken is known astronomically, it is possible to compute the length of the day from a knowledge of either the vertical or the horizontal components of the earth's rotation, or if both of these are known, the latitude and the length of the day may be directly calculated. It would seem valuable, therefore, to have a single apparatus which can measure both the vertical and the horizontal components.

In a previous paper† an experiment was described which afforded a means of measuring the component of the earth's rotation about a vertical axis. The present paper shows how the same method may be employed to measure also the components of the earth's rotation about two mutually perpendicular horizontal axes, so that the rate of the earth's rotation can be determined directly. From the ratio of the vertical component to the resultant rotation the latitude may be found, and from the ratio of the two horizontal components the azimuth may be determined.

If a circular tube filled with water is placed in a plane perpendicular to the axis about which the rotation is to be measured, one side of the tube is, in general, moving with respect to the other side. If now the tube is quickly rotated through 180 degrees about an axis in its own plane, the part of the tube on one side of the axis will have its motion changed as it is shifted to the other side, while the liquid retains a large part of its original motion. For example, if a tube bent into a ring of radius r is placed in a plane perpendicular to the earth's axis, the upper portion of the tube is moving toward the east more rapidly

* John G. Hagen, "How Atwood's Machine Shows the Rotation of the Earth even Quantitatively." (Int. Cong. Mathematicians, Aug. 1912.)

† A. H. Compton, "A laboratory Method of Demonstrating the Earth's Rotation." (Science, N. S. Vol. 37, p. 803, 1913.)

than the lower portion of the tube, since it is farther from the earth's axis, the difference in the velocities of the two parts of the tube being $2r\omega$, where ω is the angular velocity of the earth's rotation. Now if the ring is turned half way around about a horizontal axis the motion of the upper part of the tube due to the earth's rotation is retarded when turned into a position nearer the earth's axis than originally. The liquid in this part of the tube, however, will retain its original motion, and so will have a relative velocity toward the east equal to $2r\omega$. Since the pivots upon which the horizontal axis rests are constrained to follow the earth in its rotation, the component of the motion of the liquid perpendicular to the direction of the axis is without influence on the relative motion, and only that component of the liquid's momentum which is parallel to this axis will have an effect in producing a relative motion when the tube is turned. If θ is the angular distance of any small portion of the tube from the axis about which it is turned, the mean momentum per unit length of the tube which tends to cause relative motion immediately after the ring is shifted from a position perpendicular to the earth's axis through 180 degrees is

$$\rho V = 2r\omega\rho \frac{\int_0^{2\pi} \sin^2\theta \, d\theta}{\int_0^{2\pi} d\theta}$$

$$V = \omega r \qquad (1)$$

where ρ is the mass of liquid per unit length of tube, and V is the relative velocity between the liquid and the tube.

The ring used to perform this experiment was made of one inch brass tubing bent into a circle eighteen inches in diameter. Where the windows were placed the tube was constricted to a diameter of about three eighths of an inch, as in Figure I, so as to increase the velocity of the liquid at the point of observation. In order to prevent convection currents as far as possible, the tube was covered with a quarter of an inch of asbestos, and enclosed in a concentric tin tube with an intervening air space. The protected tube was then mounted on a rigid rod A (Figure I), the ends of which were made adjustable perpendicularly to the plane of the ring, so that the ring might be made able to swing upon an axis accurately parallel to its plane. An iron framework was so constructed that the axis could be supported in either a horizontal or a vertical position in order to measure either the vertical or the horizontal components of the earth's rotation.

Carbon disulphide was first used to fill the tube, on account of its low viscosity. Because of its high coefficient of expansion, however,

PLATE XI

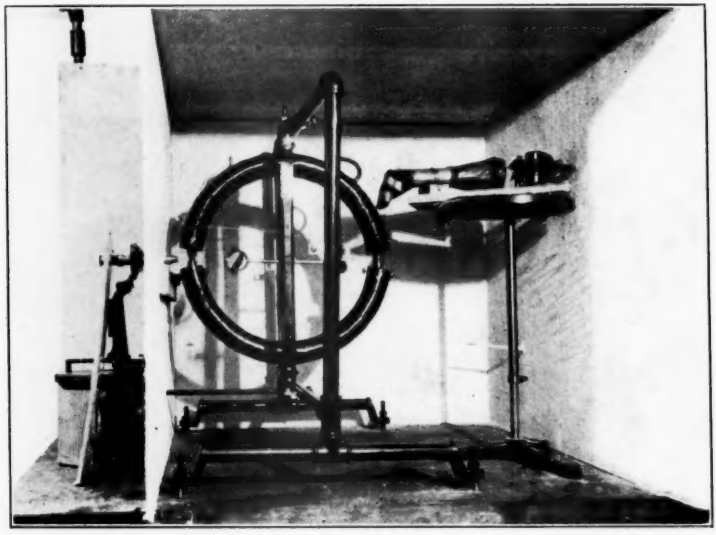


FIG. II.

MEASURING A HORIZONTAL COMPONENT OF THE EARTH'S ROTATION.

the convection currents due to slight differences in temperature in different parts of the tube rendered the use of this liquid impracticable. In fact, no liquid could be found whose coefficient of expansion was nearly as low as that of water, so this was finally

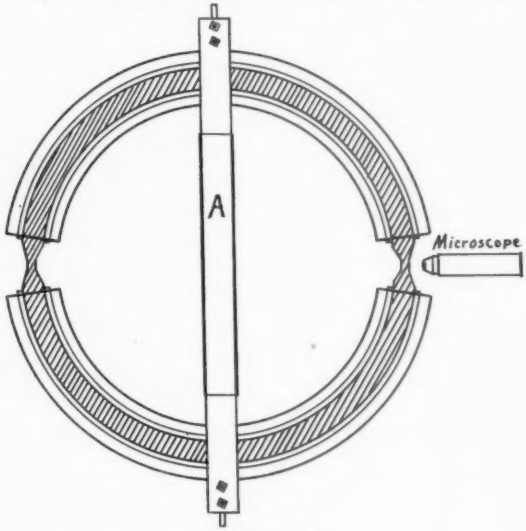


FIGURE I.

used to fill the tube. The motion of the water was made visible by shaking up with it a mixture of coal oil and carbon tetrachloride of the same density, which formed small suspended globules whose motion was easily visible through the observing microscope.

When the ring was held in a horizontal plane, no particular pains were required to eliminate convection currents, since the only time that a difference in density in different parts of the tube could affect the motion of the water was while it was being turned over. When the ring was held in a vertical plane, however, in order to measure the horizontal components of the earth's rotation, the slightest variation in density in different parts of the tube was immediately noticed. Great precautions were therefore taken to keep the ring at uniform temperature throughout. The whole apparatus was enclosed in an asbestos box, and the air within was stirred by an electric fan, as in Figure II. A further asbestos shield prevented the observer's breath from striking the enclosing box, and the surrounding air was kept well stirred by an electric fan. By this means the difference in temperature in different parts of the tube was kept within five one-hundredths of a degree, but even this small difference at

ordinary room temperature produced convection currents comparable in magnitude with the motion of the water due to the earth's rotation. In order to eliminate still further these currents, advantage was taken of the fact that the coefficient of expansion of water at 4° Centigrade is zero, so that at this temperature convection currents in large measure disappear. The apparatus was therefore set in a constant temperature room and kept at the desired temperature by means of a thermostat. In this manner it was found possible to eliminate almost entirely the effect due to convection currents.

TABLE I.

READINGS GIVEN IN SCALE DIVISIONS.

	Case *A*	Case *B*	Case *C*	Case *D*
Setting I. Axis vertical	+13	+25	+10	+24
Ring approx. ENE x WSW	+12.5	+25	+11	+14.5
	+14.8	+20.5	+13.8	+16.5
Ave. 9 r'd'gs:	+15.33	+21.19	+13.42	+19.71
X_1 = Average of 4 cases = + 17.41 divisions.				
Setting II Axis vertical.	−7	−10	−14	−8
Ring approx. NNW x SSE.	−10	−9.5	−9	−6.5
	−8.2	−13	−14	−7.5
Ave, 10 r'd'gs:	−9.70	−9.59	−12.33	−6.60
X_2 = Average of 4 cases = − 9.55 divsions.				
Setting III Ring horizontal	+14.5	+8	+19.5	+17.5
	+35	+20	+11	+30
	+10	+24	+32	+12
Ave. 10 r'd'gs:	+15.35	+18.20	+23.15	+17.10
X_3 = Average of 4 cases = + 18.42 divisions.				

$$\phi = \text{latitude} = \sin^{-1} \frac{X_3}{\sqrt{X_1^2 + X_2^2 + X_3^2}} = 42.8°.$$

$$\psi = \text{azimuth} = \tan^{-1} \frac{X_2}{X_1} = 28.7°.$$

In taking a reading, a microscope with an eye-piece scale was focused on the center of the tube under the glass window, and the ring was held in position until the oil globules had no appreciable motion. The ring was then quickly turned over, and the number of scale divisions passed by the globules between the fifth and fifteenth seconds after the ring was reversed was noted. A telegraph sounder actuated by the laboratory clock was used to measure the time during which

the motion was followed. Immediately after the ring was turned over there was a large motion across the tube, but this soon died out, and motion along the tube could be accurately measured.

Some typical readings thus obtained with the ring set in the three mutually perpendicular planes are shown in Table I. The four cases, *A*, *B*, *C*, *D*, represent the four different ways in which the ring may be turned. By taking the average of these four cases, differences in the readings due to slight convection currents and to inaccurate adjustment of the axis about which the ring is turned cancel out. The positive direction is taken as upward as seen in the microscope (a real downward motion) in the first two settings, and toward the right in the third. In the first setting observations were taken on the west side of the ring, and the fact that the water was moving relatively downward on this side after the ring was reversed indicates that the earth is revolving from west to east. Similarly the relatively upward motion observed on the east side in the second setting indicates the same sort of motion. The third setting showed a relative motion to the left on the side of the ring observed, which shows a rotation of the earth in a counter-clockwise direction about a vertical axis. Thus qualitatively the rotation of the earth about the three different axes is shown.

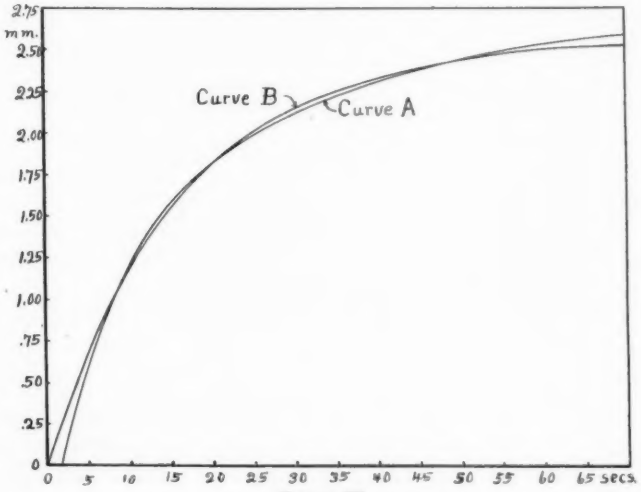


FIGURE III.

In order to make an accurate estimate of the angular velocity corresponding to any observed motion, it is necessary to find the law of motion of the water in the tube. If the motion were uniform, the

resistance would be proportional to the velocity, as assumed in the previous paper,* but this is not exactly true when the velocity changes with the time, if the motion at the center of the tube be considered. For instance, if the water in the tube is given an impulsive motion, immediately after the impulse the resistance at the center of the tube is zero, while the velocity is a maximum. However, if the greater part of the resistance occurs at definite points in the tube, as in the ring used in this experiment, the above law will hold more accurately than for a tube of uniform diameter. An experimental test of the accuracy of this law for a uniform circular tube is afforded by a comparison of the curves A and B in Figure III, taken from my previous paper. Here curve A represents the motion of the water as determined by a large number of readings, while curve B represents the motion as it would be if the resistance were proportional to the velocity, showing a rather close agreement. We shall assume, therefore, that for our present purposes the resistance may be considered proportional to the velocity, that is:

$$\frac{d^2x}{dt^2} + c\,\frac{dx}{dt} = 0$$

where x is the distance travelled along the tube, t is the time, and c is a constant depending upon the viscosity and density of the liquid and the dimensions of the tube. The solution of this equation may be put in the form:

$$X = \frac{V}{c}\left(e^{-ct_1} - e^{-ct_2}\right)$$

where X is the distance through which the motion of the water is followed, V is the initial velocity of the water after the ring is turned over, t_1 is the time of beginning, and t_2 that of ending the observation of the motion of the globules. Since in all the readings the times t_1 and t_2 were taken the same, the initial velocity of the water V is proportional to the distance X through which its motion is followed. But by equation (1),

$$V = \omega r.$$

so that X is proportional to ω, that is, the distance through which the water is followed is a measure of the component of the earth's angular velocity about an axis perpendicular to the plane of the ring. Thus if we let α be the factor of proportionality,

$$\omega = \alpha X. \qquad (2)$$

* *Science*, N. S. Vol. 37, p. 805, 1913.

PLATE XII

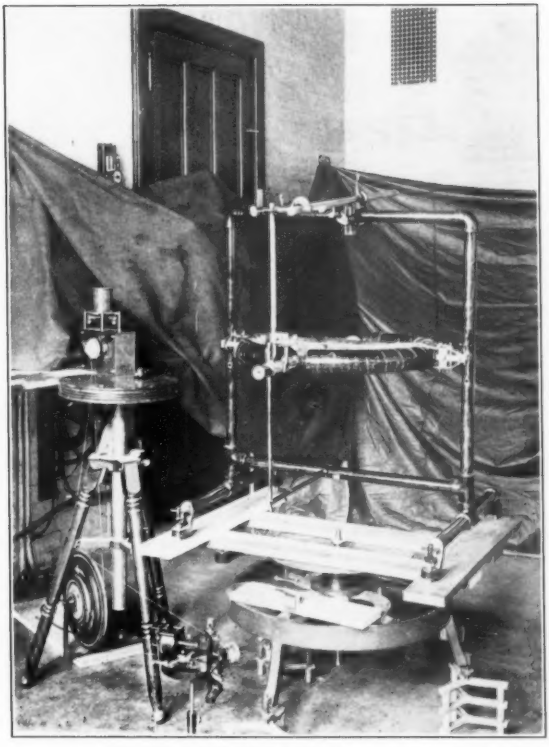


FIG. IV.

MEASURING THE ABSOLUTE MAGNITUDE OF THE EARTH'S ROTATION ABOUT A VERTICAL AXIS.

Let ξ, η and ζ be the components of the earth's angular velocity about axes perpendicular to the plane of the ring in settings I, II and III respectively, and X_1, X_2 X_3 be the average motions observed in the three settings. Then by equation (2)

$$\xi = \alpha X_1; \quad \eta = \alpha X_2; \quad \zeta = \alpha X_3 .$$

If we call ϕ the latitude and ψ the angle between the ξ axis and the north, then from Table I:

$$\left.\begin{aligned} \xi &= \omega \cos\phi \cos\psi = +\ 17.41\ \alpha \\ \eta &= \omega \cos\phi \sin\psi = -\ \ 9.55\ \alpha \\ \zeta &= \omega \sin\phi \qquad\quad = +\ 18.42\ \alpha \end{aligned}\right\} \tag{3}$$

from which

$$\begin{aligned} \omega &= 27.08\ \alpha \\ \sin\phi &= 0.680 \\ \phi &= 42.8^\circ = \text{latitude} \\ \tan\psi &= 0.548 \\ \psi &= 28.7^\circ = \text{azimuth} \end{aligned}$$

A quantitative determination of the absolute magnitude of the earth's angular velocity from these data may be made if the constant α in equation (2) is evaluated. The method employed to find this constant was a direct determination of the angular velocity of the vertical component of the earth's rotation. This was done by placing the whole apparatus upon the table of the spectrometer, as shown in Figure IV. The table was rotated by means of a driving clock at such speed that the readings taken on reversing the ring with the clock running were approximately equal but opposite in sign to those taken when the clock was stopped. So if X_4 is the observed motion of the water when the clock was stopped and X_4' that when running, the vertical component of the earth's angular velocity is

$$\zeta = \frac{-\chi}{\left(1 - \dfrac{X_4'}{X_4}\right)}$$

where χ is the angular velocity at which the spectrometer table was turning. As shown in Table II, the readings for determining X_4 and X_4' were taken in alternate sets of four, one under each of the four cases, every other set being made with the clock running. In this manner all systematic errors are eliminated, so that the accuracy with which X_4 and X_4' can be determined is a direct function of the number of readings taken. It may be noted that although X_4 and X_3 are both measures of the earth's rotation about a vertical axis, the two quantities are not directly comparable, since the temperature at which X_4 was measured was some twenty degrees higher than that for X_3, and the viscosity was correspondingly less. The quantity χ was measured directly, and was found to be $-\ 0.00585^\circ$ per sidereal second. Substi-

TABLE II.

APPARATUS ON SPECTROMETER TABLE.

Readings in scale divisions.

Clock	Case *A*		Case *B*		Case *C*		Case *D*	
	off	on	off	on	off	on	off	on
	+24		+37		+38		−12	
		−22		−10		−24		−63
	+38		+49		+21		+16	
		−49		−22		−17		−34

Average X_4 (28 readings) = + 27.5 divisions.
Average X_4' (28 readings) = − 29.9 divisions.

χ = angular velocity of spectrometer table relative to earth
= − 3° in 512.4 seconds
= − 0.00585 degrees / second
ζ = Vertical component of earth's angular velocity

$$= \frac{-\chi}{\left(1 - \frac{X_4'}{X_4}\right)} = 0.673 \text{ revolutions / day}$$

ω = Earth's angular velocity

$$= \frac{\zeta}{\sin \phi} = 0.991 \text{ revolutions / day.}$$

tuting the values of X_4 and X_4' as obtained in Table II, the vertical component of the earth's angular velocity becomes:

$$\zeta = \frac{0.00585}{\left(1 + \frac{29.9}{27.5}\right)}$$

$$= 0.00280 \text{ degrees / second,}$$
$$= 0.673 \text{ revolutions / day.}$$

But by equation (3)

$$\zeta = + 18.42\, \alpha$$

so that

$$\alpha = 0.03656$$

and

$$\omega = 0.991 \text{ revolutions / day.}$$

The length of the day as given by these data is therefore 24 hours 12 minutes in sidereal time.

These values of ω, ϕ and ψ may be compared with their values as determined astronomically, thus:

By data from earth-rotation ring:	By Astronomical data:	Difference:
ω = 0.991 revs / day	1.000 revs / day	0.9%
ϕ = 42.8°	40.4°	2.4°
ψ = 28.7°	30.1°	1.4°

The remarkable agreement of the two values of ω is partly accidental, since if the true value of ϕ is used in determining ω by data from the earth rotation ring,

$$\omega = \frac{\zeta}{\sin \phi} = \frac{0.673}{0.680} = 1.034 \text{ revs / day,}$$

which represents a difference of 3.4%. Although the comparatively low degree of accuracy of these data renders them valueless for work requiring precision, it is interesting to find that these quantities can be determined without reference to astronomical observations.

In conclusion I wish to thank Professor Russell of the Department of Astronomy for his suggestions, and Professor Magie for his kind encouragement in carrying on this experiment.

Palmer Physical Laboratory,
Princeton, N. J.
November 14, 1914.

SECOND ANNUAL REPORT OF THE SECTION FOR THE STUDY OF THE AURORAE, THE ZODIACAL LIGHT AND GEGENSCHEIN.

A. P. C. CRAIG.

Although the membership of the section has increased during the past year, little work has been done this season. This had been partly on account of bad weather and also on account of some of our members moving to a different locality, temporarily keeping them from observing. Probably the most interesting observations made were the Auroral photographs by Mr. Henry and the Zodiacal Observation made at sea by Mrs. Wilson. I hope to reproduce these, as well as the outlines of the observations we made last year, with this report. The text of the latter was published last year in P. A. for December, (Vol. XXI, No. 10) but since then it has been deemed advisable to reproduce the observations themselves, and charts giving same will be given below.

At present the membership is as follows:

E. A. McDonald, Isabella, Porto Rico.
E. L. Forsyth, Needles, Cal.
Bernard Thomas, M. B., Glenorchy, Tasmania.
Roger I. Beman, R. F. D. 8, Marshall, Mich.
Anthony Fiala, 148 83rd St., Brooklyn, N. Y.
John E. Mellish, Cottage Grove, Wis.
Lemont Barbour, New York, N. Y.
Fiametta Wilson, Bexley Heath, Kent, England.
Nels Bruseth, Los Angeles, Cal.
William Henry, New York, N. Y.

The last named member of the photographic section of the S. P. A., has presented us with a splendid set of photographs of the Aurora Borealis, which were taken from the top of the Herald Building in New York. Probably owing to a lens of wide field, which would naturally give some curvature, the auroral lines appear almost horizontal; so in examining the plates this should be taken in account.

Observations of this year being few in number, now will be the best time to publish the charts containing last year's observations. If anyone who is interested, who has no copy of the December 1913 POPULAR ASTRONOMY, will kindly drop me a line, I will be pleased to send a reprint giving the text of the observations.

Owing to the charts being rather crowded I have not attempted to date the observations, but have numbered them instead of writing the complete date on the chart, as the lettering has to be coarse, to suit the reduction in size from the original chart. Wherever possible I have numbered each observation twice, one on each side of ecliptic, each number being placed on the horizon line. For instance: Observation No. 1 in Chart 1 is at $10^h\ 0^m$ Right Ascension and was the first observation made in the season by Mr. McDonald. Obs. No. 40 is at 8^h R. A. and was his last observation in the season. In Mr. McDonald's observations each outline is numbered consecutively from 10 hours R. A. on, with the exception of 23 B, an observation with horizon at $22^h\ 30^m$. Mr. Bruseth's observations are numbered backwards from R. A. 11^h to R. A. 1^h and, are nine in number. My observations start with No. 1 at $9^h\ 40^m$ R. A., and end with No. 19 at $4^h\ 55^m$ R. A. The complete list with dates will be given below.

It takes quite a while to get all observations for each season straightened out, as several of our members live far from the United States and for this reason the report for this year is rather late.

The most interesting Zodiacal light observation so far made this year was the observation by Mrs. Wilson. In this observation the entire center of the light is set about *5° to the north of the ecliptic.* The light was 13° wide at the base, 15° wide half way up. From there on the north outline tapers roundly to the ecliptic, but the south outline is almost perfectly straight. The northern side is the abnormal side, but the complete aspect of the light is extraordinary. The abnormal condition was very noticeable and the observation was accurately made. It was made at sea in Lat. 33°.37 N and Longitude 7°.35 W. The color was yellow and it was much brighter than the Milky Way.

In our observations of the Gegenschein for last year the positions and size were given in the text. I believe that will be all that is necessary as the center and diameters are given, which are as much as any outline would give. In September it was large and round. Later

PLATE XIII

PHOTOGRAPHS OF THE AURORA, MARCH 11, 1914.

Taken from the top of the Herald Building, New York, by William Henry.

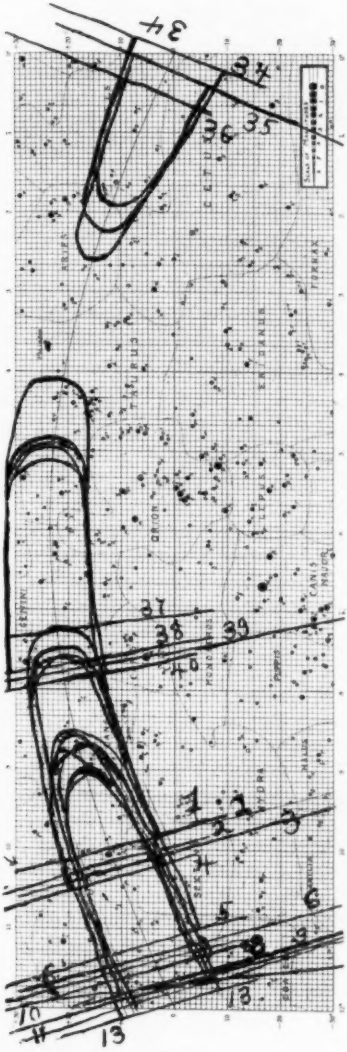


Chart No. 1.

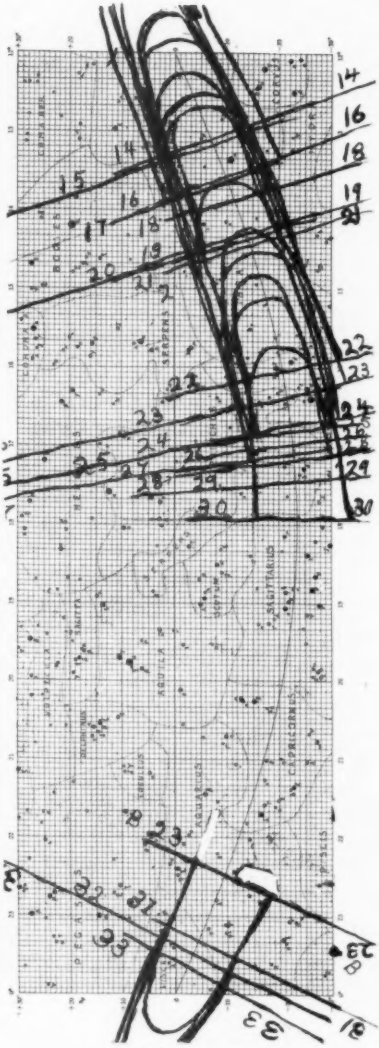


Chart No. 2.

in October it appeared to be more elongated. In October it was particularly noticeable. In November it was still elliptical, but after that it was so near the Milky Way that it was hard to determine the shape.

Mr. Bruseth has done the most work this year. Mr. McDonald has been unable to do any work to speak of and it has been the same way with myself. The rest of the members have not been heard from with the exception of Mr. Lemont Barbour, who has taken up the work lately.

Owing to the lack of space I will not attempt to discuss the observations, but I hope that the observations reproduced here will be plain enough for the readers to draw their own conclusions as to the work that we have been doing in the past two years.

We hope that other observers who are interested in the phenomena which we are observing will join us and help us turn in a large list of observations in the coming years. We invite correspondence on the subject, and will be pleased to hear from anyone who has observed or is desirous of observing with us.

Star Route Delivery, Corona, Cal. Jan. 1, 1915.

ZODIACAL LIGHT OBSERVATIONS BY E. A. McDONALD.

CHARTS Nos. 1 AND 2.

As the numbers may not be so plainly legible when the observations are reduced for publication, I will give the Right Ascension of the *Horizon* of each observation so there will be no possible chance of misidentification.

No. 1,	R.A.	10h	0m	Sept.	18,	1912	
No. 2,	R.A.	10	8	Sept.	19,	1912	
No. 3,	R.A.	10	15	Sept.	20,	1912	
No. 4,	R.A.	10	20	Sept.	21,	1912	
No. 5,	R.A.	11	12	Sept.	13,	1912	
No. 6,	R.A.	11	20	Oct.	14,	1912	
No. 7,	R.A.	11	24	Oct.	15,	1912	
No. 8,	R.A.	11	36	Oct.	16,	1912	
No. 9,	R.A.	11	40	Oct.	16,	1912	
No. 10,	R.A.	11	43	Oct.	17,	1912	
No. 11,	R.A.	11	48	Oct.	18,	1912	
No. 12,	R.A.	11	44	Oct.	19,	1911	
No. 13,	R.A.	11	56	Oct.	21,	1912	
No. 14,	R.A.	13	05	Nov.	17,	1912	
No. 15,	R.A.	13	08	Nov.	18,	1912	
No. 16,	R.A.	13	36	Nov.	20,	1912	
No. 17,	R.A.	13	38	Nov.	21,	1912	
No. 18,	R.A.	14	02	Nov.	24,	1912	
No. 19,	R.A.	14	20	Dec.	7,	1912	
No. 20,	R.A.	14	24	Dec.	8,	1912	
No. 21,	R.A.	14	28	Dec.	9,	1912	
No. 22,	R.A.	16h	04m	Dec.	9,	1912*	
No. 23,	R.A.	16	20	Dec.	13,	1912	
No. 23B	R.A.	22	24	Dec.	12,	1912†	
No. 24,	R.A.	16	24	Dec.	16,	1912	
No. 25,	R.A.	16	28	Dec.	17,	1912	
No. 26,	R.A.	17	00	Dec.	18,	1912	
No. 27,	R.A.	17	05	Dec.	19,	1912	
No. 28,	R.A.	17	12	Dec.	20,	1912	
No. 29,	R.A.	17	27	Dec.	29,	1912	
No. 30,	R.A.	18	00	Jan.	16,	1913	
No. 31,	R.A.	23	23	Dec.	29,	1912†	
No. 32,	R.A.	23	30	Dec.	30,	1912	
No. 33,	R.A.	23	40	Jan.	1,	1913	
No. 34,	R.A.	0	00	Jan.	26,	1913	
No. 35,	R.A.	0	12	Jan.	27,	1913	
No. 36,	R.A.	0	24	Jan.	30,	1913	
No. 37,	R.A.	7	16	July	22,	1913	
No. 38,	R.A.	7	40	July	27,	1913	
No. 39,	R.A.	7	47	July	29,	1913	
No. 40,	R.A.	7	52	July	30,	1913	

* (5A.M.) † (Evening sky)

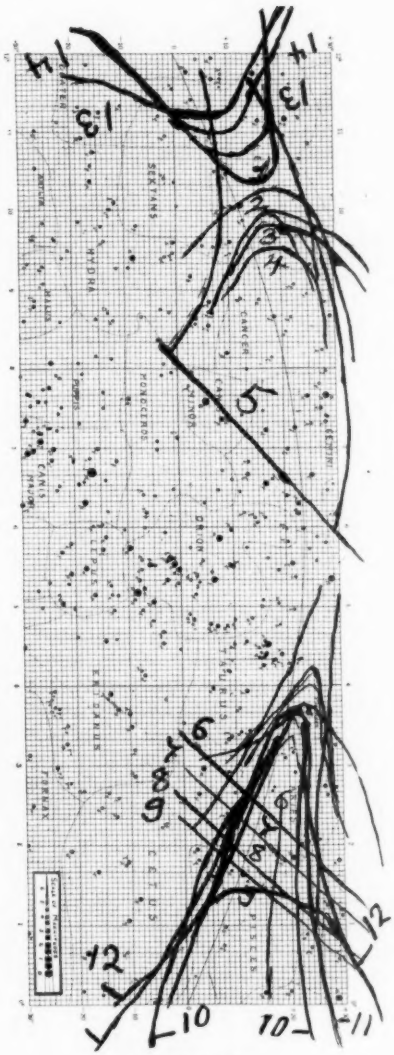


CHART No. 3.

ZODIACAL LIGHT OBSERVATIONS

By NELS BRUSETH.

CHART No. 3.

Owing to the long twilights and on account of frequent low lying fog banks in Washington, some of the horizons in Mr. Bruseth's observations have been omitted.

Therefore in Nos. 1, 2, 3, and 4 the R. A. positions are recorded at the *apex* of the light. The observation dates, positions etc., follow:

No. 1,	11h	40m	May 30, 1913
No. 2,	10	00	May 29, 1913
No. 3,	10	12	May 28, 1913
No. 4,	10	28	May 27, 1913
No. 5,	7	30	May 24, 1913
No. 6,	3	30	Mar. 24, 1913
No. 7,	3	50	Mar. 25, 1913
No. 8,	2	10	Mar. 26, 1913
No. 9,	2	20	Apr. 6. 1913

Nos. 10, 11 and 12 are observations made on Feb. 13, 15, and 19, 1914. The horizons of these observations are not shown on the chart but the apex of the light on these dates is between 3 and 4 hours R. A.

Nos. 13 and 14 are observations made on December 7 and 8, 1913. These outlines show the varying aspect of the light on these dates and the apex of each observation is from $10^h\ 20^m$ to $11^h\ 11^m$ R. A.

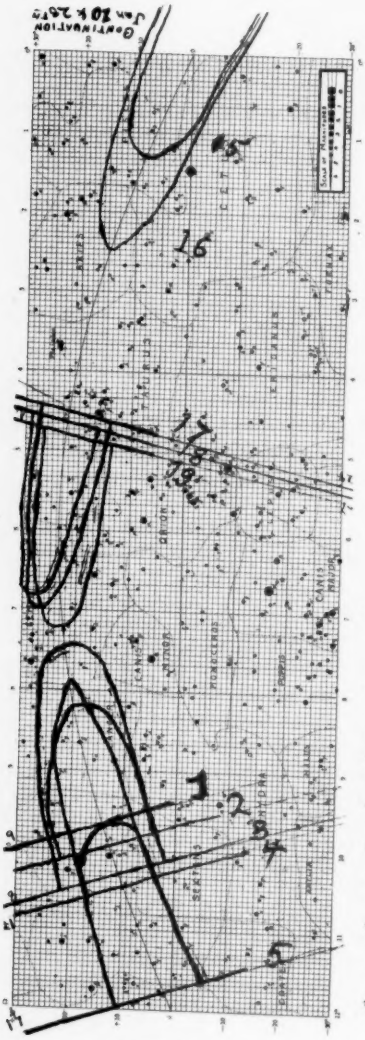


CHART NO. 4.

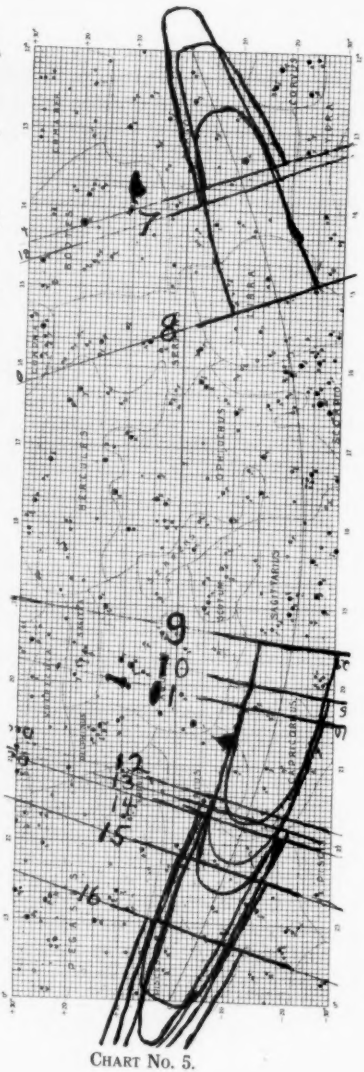


CHART NO. 5.

PLATE XIV

PHOTOGRAPHS OF THE AURORA, MARCH 11, 1914.

Taken from the top of the Herald Building, New York, by William Henry.

ZODIACAL LIGHT OBSERVATIONS By A. P. C. Craig.

Charts Nos. 4 and 5.

No. 1	R.A.	9h 40m	Sept. 9, 1912	No. 11	R.A.	20h 20m	Dec. 10, 1912
No. 2	R.A.	10 00	Sept. 12, 1912	No. 12	R.A.	21 34	Dec. 28, 1912
No. 3	R.A.	10 20	Sept. 21, 1912	No. 13	R.A.	21 40	Dec. 29, 1912
No. 4	R.A.	10 28	Sept. 21, 1912	No. 14	R.A.	21 48	Dec. 30, 1912
No. 5	R.A.	11 48	Oct. 17, 1912	No. 15	R.A.	22 20	Jan. 10, 1913
No. 6	R.A.	13 34	Nov. 14, 1912	No. 16	R.A.	23 12	Jan. 28, 1913
No. 7	R.A.	13 44	Nov. 18, 1912	No. 17	R.A.	4 30	Apr. 24, 1913
No. 8	R.A.	15 08	Dec. 10, 1912	No. 18	R.A.	4 38	Apr. 26, 1913
No. 9	R.A.	19 28	Nov. 29, 1912	No. 19	R.A.	4 48	Apr. 27, 1912
No. 10	R.A.	20 02	Dec. 6, 1912				

AN ENDOWED ASTRONOMICAL LECTURESHIP.

FREDERICK CAMPBELL, SC. D.*

The thing most needed at the present time, for the furtherance of popular interest in the Science of Astronomy, is an endowed lectureship. This should be of the "walking delegate" variety, and not shackled to any place or institution. There is no objection to its originating in and being responsible to some institution: but its work should be "foot free," peripatetic, performed here, there and everywhere, to the end that the greatest possible number of people may be reached.

There is doubtless great work yet to be done in the further establishment and equipment of observatories. Astronomy would have come to little without these in the past, and its continued progress depends on the men and instruments thus located. But observatories are not engaged in the popularizing of Astronomy; they are digging out the sober facts, which of course we must have, and are wrestling with the enormous problems which the Science imposes upon them. They are serving themselves, a few others like themselves, a handful of students interested in sharing their work, and a few score of people who read the astronomical journals, or the popular science column of a few newspapers. It remains that the great masses of the people are uninterested in and uninformed about this supreme science.

Nor does this need to be the case. Profound as Astronomy is, and unfathomable as are the depths of the sky, experience has shown that the skillful presentation of this subject to popular audiences never fails to interest, to expand the mind, to stimulate the imagination, to ennoble the character. That we can know so little about one million millions of gleaming worlds is no reason for not knowing and enjoying at least that little.

But what are the facts? Astronomy, which used to be regarded as

* Former President Department of Astronomy, Brooklyn Institute of Arts and Sciences.

an essential in a fairly liberal education, has now completely dropped out of the high school curriculum throughout the state of New York,—so the writer is officially informed,—and no doubt the same is true in most or all of the other states of the union; so of private schools for pupils of similar age. The writer has recently learned of one where 200 young ladies and girls are students, only three of whom are receiving instruction in Astronomy. In the colleges, it is true, some Astronomy is taught, though often indifferently, technically and mathematically, rather than phenomenally, usually in association with mathematics or some other branch of science. Distinguished professors of astronomy may be good delvers but poor teachers.

By far the larger number of high school students do not go to college any way; a large percentage do not even finish high school. These hosts of young people go out into life knowing nothing of any world except this little speck of dust on which they happen to be living, and indeed little enough about that. They are ignorant of what ought to be primary in their knowledge of the earth, namely, its place in the universe of worlds. They cannot tell you the difference between a star and a planet. They are amazed at the statement that the moon is not found tonight where it was last night, as an experienced teacher was to whom I spoke of it. They have no clear idea of the phenomena and causes of eclipses. They do not know one star from another, nor one constellation from another. When the subject is astronomy, they either take no part in conversation or allow themselves to be betrayed into the most egregious mis-statements. And, when they walk abroad at night, and moon and countless orbs are shedding radiance over the earth, they either do not notice at all, or else are as lost as if they were amid the labyrinth of Venetian canals. As for any thrill of healthy emotion, or uplift of soul, by reason of acquaintance with the stars, they are utter strangers to it.

We are living in an intensely material age. And, while it is true that the stars are as material as the gold and silver that allay the itching of the palm, they are counted among the immaterial, impalpable and useless things, because we cannot turn them to material account. The acutely practical spirit of our time encourages only the practical sciences, things that can be turned to account in making a living, things that can be translated into bread and butter, into coppers, nickels, dimes and banknotes. Hence the rage for agricultural courses, courses in domestic science, various kinds of engineering, etc., all good enough in their places, yet all of the earth earthy, all pertaining to the little place where we are and the little time when we are, while every night over our heads the majestic truths of eternal duration and infinite space are being silently spelled out by the heavenly bodies. Astronomy

does have its practical side, however. This we insist upon; for by it men sail the trackless seas, and by it the seasons are measured and consequently all the affairs of life regulated. But even if this were not so, it is deplorable beyond words that men, who have capacity for such infinite conceptions as the stars afford, are doomed to live in ignorance of all the universe except their own insignificant corner called earth, a sphere that could not even be seen at one third its distance to the sun.

The observatories are already splendidly equipped; and there are plenty of them, girdling the world like a chain. What we now want is to unlock the treasures of the observatories, to let the light stream out of them that has streamed into them; to translate the great facts and figures which they have accumulated into the familiar language of the people; to make easy to the average mind what has been hard even to the trained mind; to inspire a thousand at a time with the splendor, romance and magnificence of the universe, which have again and again heaved the bosom of the lonely astronomer as he has kept his vigil at night. This can be done; on a very small scale it is being done. Its possibility and utility have been abundantly demonstrated. The next man or woman, believer in education and in general enlightenment, and lover of his less fortunate fellowmen, should endow a lectureship, and make his gift, not to an already well equipped institution, but rather to the people.

Such a benefactor should select his lecturer and bid him go and go and keep going, among schools, seminaries and colleges; among churches, clubs and societies; among villages, towns and cities; beside his salary, covering all the incidental expenses, including the very finest possible lot of lantern views; and freely inviting the people everywhere to enjoy all that astronomy has to present them. Boards of Education would welcome this everywhere, and provide both place and equipment. In some degree it would supply the place made vacant by the loss of Astronomy. It would insure that young people and old would get at least some conception of astronomical truth and not be totally ignorant. It would contribute to the betterment of any community. It is of course well known that similar lectures and lectures on many other subjects, are constantly provided by the New York City Board of Education, free to the public, in 175 centers.

The lecturer might be given the particular task of visiting all the high schools of a single state, or of a number of states. Or those in the larger towns throughout the land could be selected. Or, through Boards of Education, arrangements could be made for school lectures in the afternoon, general lectures in the evening, during one, two or three days. A nobler work for the promotion of the intelligence of the people can hardly be imagined.

Beaver Falls, New York.

REPORT ON MARS, No. 8.

WILLIAM H. PICKERING.

Early in 1913 it occurred to the writer that it would be desirable to obtain if possible an authoritative representation of the appearance of Mars at the following opposition by a small association of recognized experts. The surface of Mars changes so clearly from one opposition to the next, quite independently of its seasons, that it is certain that the most reliable record possible at each opposition should be left by us to posterity, and the sooner this fact is generally recognized the better.

After consultation with a number of prominent American astronomers, and also with the Council of the British Astronomical Association, it was decided that the writer should invite a certain number of American experts to contribute drawings, and that the Association should similarly invite certain European astronomers to do the same, and that the results should be published in the Memoirs of the Association. A circular was issued by the writer which was sent to all the contributing astronomers, of which the following is an extract:—

"It is proposed that an effort be made to secure drawings of six different aspects of the planet Mars at this next opposition, the drawings being made at several different observatories. The central meridians will be at 0°, 60°, 120°, 180°, 240°, and 300° Martian longitude. It is allowable for the observers if they choose to study the planet upon previous evenings and to make preliminary sketches. They may even sketch in the main features of the disk on the final drawing on a previous night, if they wish, but nothing must be drawn which is not certainly visible within the hour selected. Notes of suspected features, and also a list of those canals which can be held steadily for three seconds, should any such be found, may be added. A statement should also be made regarding the seeing, aperture, and magnification employed. Remarks on the visibility of the finer divisions in Saturn's rings just previous to beginning the drawings would also be useful. Photographs of Mars, taken as soon as possible either before or after the drawings are made, or at corresponding hours upon other nights, would be desirable.

The object of the investigation is three-fold: (A) To determine, as a result of investigation by the most practised living observers of Mars, what should be generally accepted as *definitely known* surface markings. (B) This investigation should also enable us to determine if many of the so-called canals can be seen in the same places on the

PLATE XV

Fig. 1
Phillips A

Fig. 2
Pickering A

Fig. 5
Phillips B

Fig. 6
Pickering B

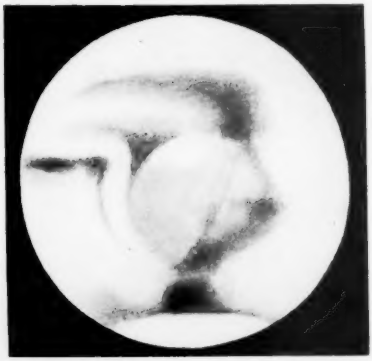


Fig. 9
Phillips (Sup.)

Fig. 10
Pickering C

PLATE XVI

Fig. 3
Douglass A

Fig. 4
Slipher (Sup.)

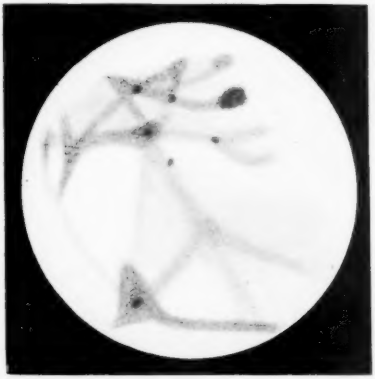


Fig. 7
Douglass B

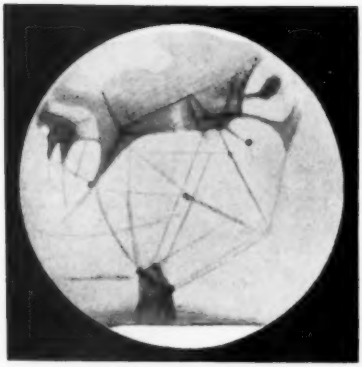


Fig. 8
Slipher B

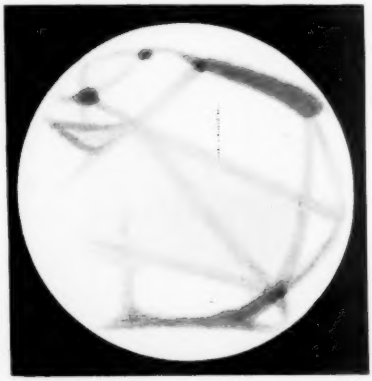


Fig. 11
Douglass C

Fig. 12
Douglass (Sup.)

planet, and presenting the same appearance, to different widely located observers, at about the same time. Also, if they can be held in steady vision for an appreciable interval. Our views on their objective reality should be influenced by the result, and the question perhaps definitely settled. (C) It is known that certain astronomers believe, that, where it is not a question of the amount of light, climate is everything, and aperture, within rather wide limits, of comparatively little consequence. If this view is correct, it is certainly desirable to find it out. If it is not correct it is important that that also should be determined."

All the American astronomers invited, except Professor Barnard were able to contribute. He reported almost continuously cloudy weather at the Yerkes Observatory, and when clear the seeing was unfavorable. On the other hand although several European observers had agreed to furnish drawings, only one was able to do so. For various reasons considerable delay in the publication of the results occurred, and the writer finally proposed to the Association, in order to expedite matters, to take the whole question of publication off their hands, and have the results appear in one of his Reports on Mars. To this the Council of the Association very kindly agreed, although some work had been already done by their committee, and indeed their contribution is much larger than appears on the face of it.

The observers who took part, with their equipment are as follows:—

Rev. P. E. R. Phillips, Ashtead, Surrey, England. 12¼-inch reflector by Calver, and 8-inch refractor by Cooke. Magnification employed 230 to 400. Scale of seeing 1 excellent, 5 very bad.

Dr. Percival Lowell and Mr. E. C. Slipher, Flagstaff, Arizona. 40-inch reflector and 24-inch refractor, both by Clark, apertures ranging from full size down to 14 inches. Magnification 365 and 392.

Professor A. E. Douglass, Tucson, Arizona. 8-inch refractor by Clark. Full aperture. Magnification 220 and 340, usually the latter. Seeing on the standard scale, ranging from 5 to 9.

Professor W. H. Pickering, Mandeville, Jamaica. 11-inch refractor by Clark. Full aperture. Magnification 330 and 660. Seeing on standard scale ranging from 10 to 12.

In the four plates illustrating this article the figures are arranged in four columns of six rows each. Each row, as far as may be, consists of views of one of the six selected areas of the planet. The first row shows region **A**, second row region **B**, and so on. When an observer was unable to furnish a complete set of views, the space is filled with a supplementary drawing, as for instance Figure 9 of Plate XV. Each column, as far as possible, consists of the work of one observer, the columns being arranged in the order of the longitudes of their stations.

In general therefore the views on the left were drawn a few days before those on the right. The last column on Plates XVI and XVIII contains three regular and three supplementary drawings, the latter being by Messrs. Slipher, Douglass and Lowell.

In Table I are given the data regarding these views. The first four columns require no explanation. In the fifth the seeing is not given by the Lowell Observatory. Mr. Phillips numbers it in the inverse order to the other observers, 1 indicating his best. The others both use the standard Scale H. A. **61**, 29, so called because each division of the scale can be accurately described and recorded. Perfect seeing with a 5-inch aperture is marked 10 on this scale. Doubling the aperture adds two units to it, which for an 11-inch aperture therefore makes perfect seeing 12. This requires that the outer rings of a bright star shall either be stationary, or else exhibit only a very slow motion, when seen with a ¼-inch eye-piece. Such an eye-piece gives a magnification of about 60 to each inch of aperture. The sixth column gives the date

TABLE I.

DATA RELATING TO THE FIGURES.

No.	Obs.	Aper.	Magn.	Seeing	1913,4	Reg.	Long.	Δ Long.	Lat.	Diam.	M. D.
							°	°	°	″	
1	Pl	12	—	2	Dec. 29	A	5	+5	+6	15.0	Apr. 2
2	Pk	11	330,660	10	Jan. 4	A	5	+5	5	15.0	" 5
3	D	8	220,340	7	" 8	A	352	−8	4	14.9	" 7
4	S	14,17	392	—	" 13	—	315	—	3	14.6	" 10
5	Pl	12	—	2	Dec. 21	B	97	+37	7	14.8	Mar. 30
6	Pk	11	330,660	10	" 31	B	64	+4	5	15.0	Apr. 3
7	D	8	340	8,9	Jan. 3	B	58	−2	5	15.0	" 5
8	S	24,14	392	—	" 6	B	42	−18	4	15.0	" 6
9	Pl	12,8	—	2	Dec. 27	—	28	—	6	15.0	" 1
10	Pk	11	330,660	12	" 25	C	125	+5	6	14.9	" 1
11	D	8	340	8,9	" 29	C	116	−4	6	15.0	" 2
12	D	8	220,340	7	" 22	—	166	—	7	14.8	Mar. 30
13	Pl	12,8	—	1·5,2	Jan. 17	D	174	−6	3	14.3	Apr. 11
14	Pk	11	330,660	10	Dec. 17	D	185	+5	8	14.5	Mar. 28
15	D	8	340	8,9	Jan. 25	D	191	+11	2	13.6	Apr. 15
16	L	40	365	—	" 21	—	229	—	2	14.0	" 14
17	Pl	12	—	1·5,5	" 11	E	231	−9	4	14.7	" 9
18	Pk	11	330,660	10	" 18	E	240	0	2	14.3	" 12
19	D	8	340	7,9	" 24	E	248	+8	2	13.7	" 15
20	S	40	365	—	" 21	E	245	+5	2	14.0	" 14
21	Pl	12,8	—	1·5	" 3	F	319	+19	5	15.0	" 5
22	Pk	11	330,660	11	" 17	F	284	−16	3	14.3	" 12
23	D	8	220,340	5,8	" 13	F	294	−6	3	14.6	" 10
24	S	14	392	—	Dec. 12	F	284	−16	9	14.2	Mar. 25

of observation, the seventh the region of Mars observed, and the eighth and ninth the recorded martian longitude, and difference of longitude from that required by the circular. The tenth column gives the latitude of the center of the disk. The last two columns give the diameter and the martian date.

It is the writer's belief that there are still a few astronomers left who either deny that canals exist on Mars, or else assert that their existence has not yet been proved. For this reason it may be worth while to devote a few lines to considering the resemblances between the accompanying drawings, before entering on the more interesting subject of their differences.

If the reader will examine region **E** and **F** shown in the two lower rows of Plates XVII and XVIII, it is believed that he cannot fail to be impressed the fact that the four observers all saw the same markings and that these markings were real. Figures 16 and 20 were drawn independently by two observers on the same night with the same instrument. The elongated narrow dark areas shown in these nine drawings are the so-called canals. The fact that in some cases, as in Figures 6 and 7, one observer shows a number of canals not shown by the other does not affect the question. When the canals first appear they are often exceedingly faint, broad, and ill-defined. Probably something of this sort was seen in the lower part of the disk, which Professor Douglass interpreted as canals, and which the writer interpreted otherwise. The fact that they clearly saw the same canals in the upper part of the disk shows that these latter canals, like those shown in regions **E** and **F**, actually exist on the planet. It must be remembered that the planet is rapidly revolving on its axis, and therefore that the canals are constantly shifting their places from west to east. The central meridian in these two cases was in longitudes 64° and 58°. In Figure 8 it was only 42°, while in Figure 5 it was 97°.

In saying that the canals actually exist, we mean to say that they are straight or curved elongated markings, and that they are not due to irregularly distributed separated dots and fine detail, not recognizable as such, but integrated by the eye into lines. This latter question has been already dealt with at length in Report No. 6, and need not be further considered here. As to the explanation of the canals, that is still a different question, dealt with in Reports Nos. 6 and 7, and has nothing whatever to do with the present point that the canals so-called really exist as dark elongated markings.

In this Report No. 7 the writer says "The most important question of the observer's personality, however, relates to the proportions and position of the main markings and canals. Here, however, the writer believes that personality has but little effect, and that the general shape is in all these cases pretty accurately represented." It is thought the present series of drawings corroborates this view, and that the drawings presented in the former Report may therefore be relied upon to represent accurately the general form and position of the chief canals and other details, and also the very striking change in character of the detail itself, shown at the various oppositions there represented.

When we come to discuss the differences between the drawings, it should be remembered that the disk of Mars, with the usual magnification of 400, appears nearly twice the diameter of the moon as seen through an ordinary opera glass, although of course not quite so sharply defined. Bearing this fact in mind, it is perhaps rather surprising that the drawings should differ among themselves as much as they do. In some cases, as in Figure 22, the formation of the large dark blue central spot is due to an actual change, of brief duration, already described in Report No. 4. This change, as far as the writer's observations indicate, began January 15, was very pronounced on the 17th, and rather less so on the 18, (see Report No. 6 Figure 2). In February nothing unusual was seen. Another sudden change, although less marked, occurred in the region preceding Solis Lacus (Figures 5 to 8) and is described in Report No. 3. It will be referred to again later. A similar rapid change was observed by Schiaparelli in 1886, in the Lacus Hyperboreus (Flammarion 2, 13).

Such changes however are unusual, and, leaving them aside, it is a matter of interest that the planet should present two distinct kinds of appearance to different observers, the appearance it presents to Messrs. Lowell and Slipher, and the appearance it presents to the other three. It might at first be suggested that this is due to the difference of aperture employed, Figure 20 for instance being drawn with an aperture of 40 inches, and Figure 19 with an aperture of 8. That this is not the true explanation, however, will be seen if we compare Figures 20, 21, 22, and 24. The last three were drawn with apertures of 12, 11, and 14 inches respectively, yet Figure 24 shows the same narrow lines and minute detail represented in Figure 20, drawn with three times the aperture, while it is utterly unlike Figures 21 and 22 where the apertures were very similar.

When the writer erected the first dome and 18-inch telecope at the Lowell Observatory in 1894, he and Professor Douglass saw the canals then exactly as they see them now, as grey markings of appreciable breadth, while Professor Lowell saw them always as fine lines. It is clearly then a question of personality and interpretation of what is seen, not of instrument or atmosphere. Doubtless if Professor Lowell should go to Tucson, he would still see the canals as fine lines, not as Professor Douglass sees them, and *vice versa*. In point of fact the writer holds a somewhat intermediate position between the other two. Sometimes he does see the canals as fine lines, see Figure 6, notably the canal leading to Juventae Fons, which is quite as narrow as anything drawn by Messrs. Lowell and Slipher, about 0″.05. It may be remarked incidentally that the seeing was rather inferior on that night, being only 10, while in Figures 10 and 22, where all the canals are broad, it

PLATE XVII

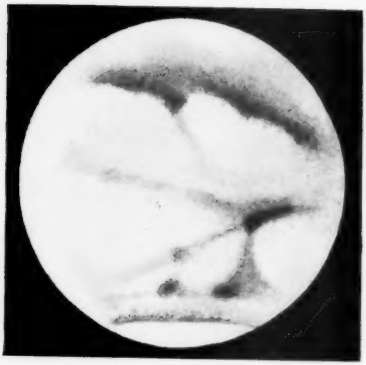


Fig. 13
Phillips D

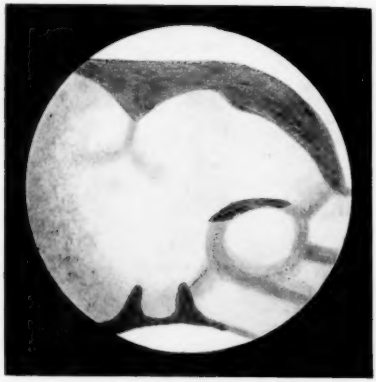


Fig. 14
Pickering D

Fig. 17
Phillips E

Fig. 18
Pickering E

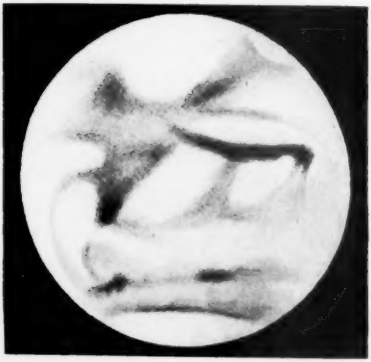


Fig. 21
Phillips F

Fig. 22
Pickering F

PLATE XVIII

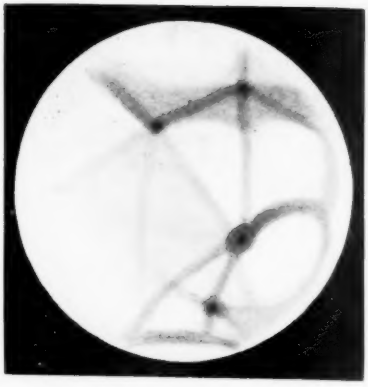


Fig. 15
Douglass D

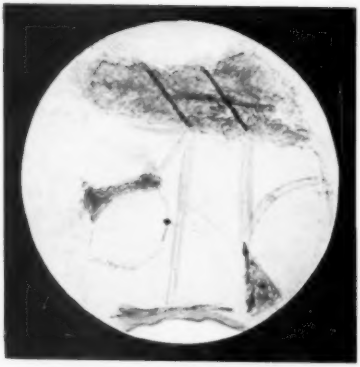


Fig. 16
Lowell (Sup.)

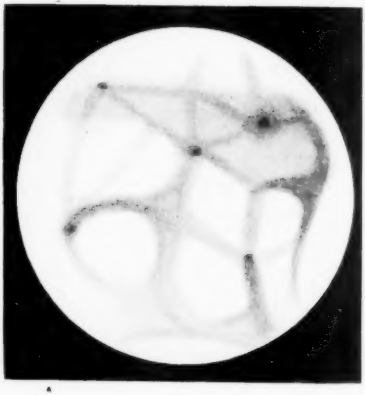


Fig. 19
Douglass E

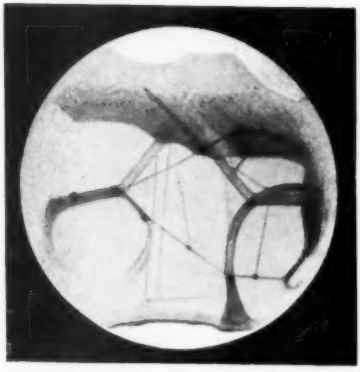


Fig. 20
Slipher E

Fig. 23
Douglass F

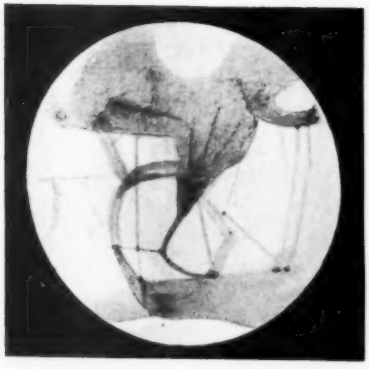


Fig. 24
Slipher F

was 12 and 11. In the writer's case the seeing, if reasonably good, has nothing to do with the appearance, it is a question of the canal itself.

According to his experience the canals are fairly wide markings when they first appear, after the melting of the polar caps, and then gradually narrow as the summer comes on. See Report No. 6. At the next opposition he expects to draw them appreciably more narrow than in his present series of sketches. In the present series it is interesting to note that Messrs. Phillips, Douglass and the writer agree surprisingly well as to their breadth, while Messrs. Lowell and Slipher agree with the others on this point only when they see them double.

In this connection it may be of interest to mention some measures recently made by the writer of the breadth of some of the coarser lunar canals, as a means of testing his Scale of Canals, described in his last Report. The canals selected for measurement were the wide double shown in Figure 1 of Report No. 6, stretching northwest from Tycho, the canal extending northeast from the northern side of Copernicus, and the narrow canal extending from Mare Humorum to Kepler. These were observed with a field glass, the observer being seated at the eye-end of the telescope.

TABLE II.

WIDTH OF LUNAR CANALS..

Canal	Mm	Arc	Miles	Photo	Ratio	Corr	C—P
		"					
Tycho	6.5	72	84	69	.82	70	+1
Copernicus	4	44	51	50	.98	43	—7
Humorum	3	33	38	25	.66	32	+7
Mean					.82		+5

In the table the successive columns give the name of the canals, its width measured on the scale attached to the telescope, this value reduced to arc, and then to miles, the value measured from the photograph in miles, and the ratio of the two. This gives a mean correction to the observed value of. one sixth. Subtracting this gives the corrected value, and this minus the photographic value gives the deviations in miles recorded in the last column, which is sufficiently close for measures made at that distance with a field glass.

The number of canals is too few to deduce a reliable correction, the difficulty being that while there are plenty of lunar canals visible with the field glass, when we come to identify them on the photograph, the markings which produce them are of such irregular breadth and shape, that it is very hard to decide what we shall call their real breadth. If the same is true upon Mars, then there is no doubt but this method of measurement gives all the accuracy needed for the work.

In the early days of the discussion as to the reality of the canals, the question was sometimes raised, do the observers who have studied Schiaparelli's maps see the canals in the same places as he, because they have memorized his maps, and have then drawn what they expected to find? Any observer who has seen the canals clearly, would be prepared to indignantly deny such a suggestion as applied to his own particular case. Nevertheless the observations made this year of the point known as Fastigium Aryn lying between the two bays of Sinus Sabaeus indicate that perhaps this suggestion in the case of certain details is not without some basis of fact. Aryn is usually a very conspicuous marking, and as such has been chosen to mark the meridian from which all martian longitudes are reckoned. Some time before the past opposition, the writer made up his mind to make some micrometer measures of the position of this point for comparison with earlier measures made by himself in 1892, and by other observers, in order to determine the period of rotation of the planet. He therefore paid especial attention to the place of this particular marking throughout the opposition, examining it carefully at every opportunity. He did not however clearly see it once. As late as February 14 he recorded "Aryn certainly not visible." It was not until March 21, when the apparent diameter of the planet was reduced to 8″.3, that he was at last able to record "suspect Aryn, but by no means sure of it, on account of distance of the planet." It was then of course too late to measure its position by the micrometer.

Now the interesting feature of this seeming digression lies in the fact that in six of the drawings, numbers 1, 3, 4, 8, 9, and 21, Aryn is distinctly, and sometimes conspicuously shown. Three of the other observers therefore apparently saw it clearly. Moreover their representations are confirmed by some observations and drawings recently sent me which were made by Mr. McEwen of Glasgow. To me the appearance was always as in Figure 2,—a perhaps novel, and certainly unusual form. The question the writer wishes to raise is this: Did four other practiced observers, knowing how Aryn ought to look, and that it generally presented the same appearance, draw it as they thought it should appear, or was the writer especially blind to that particular conspicuous marking? Was this a case of seeing double what was expected to be double, or was it not?

Aryn is so conspicuous between the two bays of Sabaeus in the drawings of both Messrs. Douglass and Slipher, that if they are correct in their representations of it, it does not appear possible that the writer could have overlooked it, even if he had not been searching for it. But it was not that he simply missed it, he was able to use a higher magnification to advantage than they did, and saw and drew something

different. While he admits his minority position, he thinks that he is right in this matter, and feels that he cannot assert too strongly his belief that no observer, no matter how practiced, should take anything for granted on Mars. The more conspicuous and constant a marking is, the more necessary it is to follow this precept.

The writer would point out in this place that in Figure 18 the boundary line between the dark and bright regions near the center is clearly too far to the north, as is shown by the three other drawings of this region. This statement is corroborated by other drawings of the writer, notably one made two nights later. The error amounts to about 1″.2, and is exceptionally large. In Figure 14 the boundary appears to be too far to the south by about half this amount, but this is largely explained by the fact that it was drawn in December when the south pole was more turned away from us than in January, when the other drawings were made. Errors exceeding 1″ do not often occur in latitude in carefully made drawings, at least none other has been found by the writer in the twenty drawings of standard regions here shown and this may be taken as a general statement of fact. Larger errors may occur in longitude however, and would be harder to detect. These might be due in part to phase, and in part to the rapid rotation of the planet, amounting to 550 miles per hour at the equator or 2″ to 3″ at different oppositions, so that unless the main features of the disk are quickly drawn, and the details filled in later, errors will occur from this source.

It is generally supposed that incomplete canals do not exist upon the planet, that every canal both begins and ends either in some other canal, or in some definite dark region. That this is not strictly true is indicated by Figures 9, 13, and 14, where canals terminate near the center of the disk in the open desert regions.

In this connection a list of the canals seen by the different observers may be of interest. Three sets of drawings are nearly complete. Drawings of only three of the required regions were furnished by the Lowell Observatory, and for this reason it was decided, with some regret, not to include them in this investigation. It may be said however that in those regions they indicated more canals than either of the other drawings. The supplementary drawings are also excluded. The identification was made in each case by the writer. This was quite necessary, since different observers would be likely to differ in the case of certain canals. For example Professor Douglass in a list which he transmitted did not include either Nepenthes or Thoth, two canals very conspicuous in his drawings. The explanation is that he apparently did not consider the former to be a canal, on account of its width, and the latter he identified as Amenthes.

Thus in comparing the lists of canals identified by different astronomers it is very necessary to compare their maps at the same time. The writer employed primarily Schiaparelli's map, Report No. 1. Those canals not found on it were identified by the map of the opposition of 1896,7, Annals Lowell Observatory **3**, 100.

TABLE III.

CANALS RECORDED BY MESSRS. PHILLIPS, PICKERING, AND DOUGLASS.

No.	Canal	Pl	Pk	D	No.	Canal	Pl	Pk	D
1	Achates L		F	EF	41	Hades			CD
2	Achelous L	E	DE	DE	42	Heliconius	E	DE	DF
3	Agathodaemon	B	BC	BC	43	Helisson L			D
4	Ambrosia			C	44	Hephaestus		DE	EF
5	Anian		D	E	45	Hiddekel	F		FA
6	Araxes		C	C	46	Hyblaeus	E	DE	DE
7	Arsanias L			A	47	Hydraotes	B		
8	Astapus			E	48	Hylias L			F
9	Ausonium L			EF	49	Indus			AB
10	Baetis L		B		50	Isis L			C
11	Boreas	D	D	D	51	Jamuna			B
12	Boreosyrtis	E	EF	EF	52	Jobares L			B
13	Caicus L		B	B	53	Laestrygon			DE
14	Catarrhactes L			C	54	Labadon L	B	C	C
15	Callirrhoe	FA	A	FA	55	Leontes L			D
16	Casuentus L			F	56	Nectar	B	BC	BC
17	Cerberus	DE	DE	DE	57	Nepenthes	EF	EF	EF
18	Chrysorrhoas	B		C	58	Nilokeras	AB	AB	B
19	Coprates L		B	B	59	Nilosyrtis	F	EF	E
20	Cyaneus L			D	60	Nilus			B
21	Daemon L	B	BC	C	61	Orcus	D		CD
22	Dardanus	B			62	Orontes	F		
23	Dargamanes L		B	B	63	Oxus			A
24	Deucalionis	FA	A	A	64	Phison	F		A
25	Deuteronilus	FA	A	A	65	Phlegethon	D		C
26	Dyras L			EF	66	Polyphemus			
27	Eosphoros		C	C	67	Protonilus	F		F
28	Erebus	D		D	68	Pyriphlegethon			CD
29	Erymanthus L			E	69	Scamander			D
30	Eumenides			C	70	Sonus L			B
31	Eunostos	E	DE	DE	71	Styx	DE	DE	DE
32	Euphrates	F		A	72	Tanais	B	B	B
33	Eurotos	DB			73	Tartarus	D	D	D
34	Galesus L			E	74	Thoth	EF	EF	EF
35	Ganges	B		B	75	Titan		D	D
36	Garrhuenus L		B	B	76	Tithonius L	B	B	C
37	Gigas	B	D	D	77	Triton		E	EF
38	Gihon	F		A	78	Xanthus			E
39	Glaucus L		B	C	79	Anonymous			A
40	Gyndes			CD	80	"	E		

In Table III the first two columns give the number and name of the canal. In case it is taken from Lowell's map the name is followed by an L. The remaining columns indicate the work of the three observers, the letters in these columns indicating the drawings on which the

canals appear. Of the 80 canals observed 52, or two-thirds, were given by Schiaparelli, 26 are taken from Lowell's map, and 2 are anonymous. Of these last, one shown in Figure 3 lies south of Deucalionis, and is in part confirmed by Figures 1 and 2. The other shown in Figure 17 is extremely faint, and is situated south of Cerberus and nearly parallel to it. Mr. Phillips "strongly suspected" it on several occasions, and it is corroborated as a duplication of Cerberus by a drawing of Schiaparelli made in 1883, 4 (Flammarion **2**, 5).

But besides recording all the canals seen at an opposition, it is a matter of interest to record those that are characteristic of it. With this end in view Table IV has been compiled. The first column gives the number of observers by whom the various canals were identified, the second, third, and fourth, the number of canals represented by each observer, and the last the total number. Thus Mr. Phillips saw 24 canals confirmed by the other two observers, he saw none confirmed by the writer alone, but 9 that were confirmed by Professor Douglass. He saw 5 which neither of the others was able to confirm, 38 in all. The last column indicates that there were 24 canals seen by all three observers, 21 seen by only two, and 35 seen by only one, 80 in all. Professor Douglass saw many more canals than either of the others. The writer saw the fewest, moreover two of his canals were located in region **C** not observed by Mr. Phillips.

TABLE IV.

SUMMARY OF CANALS VISIBLE.

Observers	Phillips	Pickering	Douglass	Total
3	24	24	24	24
2	0 Pk	0 Pl	9 Pl	—
"	9 D	12 D	12 Pk	21
1	5	1	29	35
Total	38	37	74	80

It is possible that the writer was too conservative in deciding what canals he should enter on his drawings. He believes that it is always well to discover too little, rather than too much, and he made it a point to draw nothing that he could not hold in steady vision for as long a time as he chose to look at it. As a result he has but one canal that is not confirmed by one or both of the others, and that one Baetis, leading to Juventae Fons in Figure 6, is confirmed by Mr. Slipher in Figure 8. He feels convinced that all the canals he drew were really there, but at the same time he is quite prepared to admit that all that the others drew, and that he himself did not see, were there also.

The 24 canals that were so clearly seen and accurately drawn by all three observers that there seemed to be no question of their identity in the drawings, have been identified by the writer as Achelous L, Agathodaemon, Boreas, Boreosyrtis, Callirrhoe, Cerberus, Daemon L, Deucalionis, Deuteronilus, Eunostos, Gigas, Heliconius, Hyblaeus, Lapadon L, Nectar, Nepenthes, Nilokeras, Nilosyrtis, Phlegethon, Styx, Tanais, Tartarus, Thoth, and Tithonius L.

Of these the five Boreosyrtis, Cerberus, Nepenthes, Nilosyrtis, and Thoth were markedly conspicuous. Callirrhoe, Heliconius, and Tanais merely marked the southern border of the melting northern polar cap, and for that reason should perhaps hardly be classed as canals. At all events they differed from the others.

The twenty-one canals which were seen or suspected by two observers are Achates L, Anian, Araxes, Caicus L, Chrysorrhoas, Coprates L, Dargamanes L, Eosphoros, Erebus, Euphrates, Ganges, Garrhuenus L, Gihon, Glaucus L, Hephaestus, Hiddekel, Orcus, Phison, Protonilus, Titan, and Triton. The thirty-five canals seen by only one observer are Ambrosia, Arsanias L, Astapus, Ausonium L, Baetis L, Catarrhactes L, Casuentus L, Cyaneus L, Dardanus, Dyras L, Erymanthus L, Eumenides, Eurotas, Galesus L, Gyndes, Hades, Helisson L, Hydraotes, Hylias L, Indus, Isis L, Jamuna, Jobares L, Laestrigon, Leontes L, Nilus, Orontes, Oxus, Polyphemus, Pyriphlegethon, Scamander, Sonus L, Xanthus, and two anonymous canals. A number of these faint canals doubtless owe their presence on this list solely to inaccuracy of the drawings. Had they been more clearly seen, and therefore better drawn, they would have been found to coincide with some of those on the preceding list. On the other hand it must be remembered that these lists do not by any means contain all the canals observed at this opposition, even here in Jamaica, but only those found on a few selected drawings made durings a period extending a little over six weeks. Other drawings by the writer confirm several of the canals mentioned in this last list.

The question may now be properly raised how many canals is it worth while to observe. To know the ten, twenty, or forty most conspicuous and characteristic canals of an opposition is a matter of interest, but to print a list of a couple of hundred is of no interest at all. The writer recommends that in future observers who see great numbers of canals should divide them into two lists, one list containing forty or fifty canals that can be steadily held, and the other list the more difficult ones that can only be glimpsed.

Allied to this discussion is the question of how many canals it is proper to name. There are now several hundred names on our lists, and until recently they have been rapidly increasing. It is worse than

the case of the asteroids, because we know at least that the latter when once named are all there. Some of the canals on our lists should certainly be identified with other recognized canals. This is in part due to different observers giving different names to the same canal, in part to errors of identification, and in part to the occasional transverse or angular displacement of the canals themselves. Thus the same canal when occupying two slightly different positions or presenting two different position angles will receive two different names. The writer would recommend that at each following opposition all canals that have not been seen for fifteen years should be dropped from our lists. The problem would thus gradually solve itself, at least in part.

An interesting illustration of shifting canals similar to those mentioned in Reports Nos. 6 and 7, is shown in Figure 14, where Gigas and Tartarus join Titan just below Sinus Titanum, instead of joining the Sinus directly, as is usually the case. This drawing was made December 17, and is confirmed by others on December 18, 19, 22, and 23. By January 13 however, in Figure 13, Mr. Phillips shows Tartarus in its usual position. In Figure 15, January 25, Professor Douglass shows both Gigas and Tartarus as they are usually drawn, and this is corroborated by a drawing of the writer made February 1. The canals apparently travelled some 300 miles across country in about three weeks, that is at a speed of 15 miles a day. In that time they traversed their full breadth.

An early observation of shifting was recorded by Schiaparelli in the case of a straight nearly meridional canal, measuring 3000 miles in length, and designated by him as Euphrates-Arnon-Kison. This canal which in 1886 had pointed to the left of the northern polar cap, in 1888 pointed to the right of it, a shift of some 400 miles at the cap (Flammarion **2**, 18). Such observations, while perhaps favorable to the idea of intelligent direction upon Mars, do not strengthen the theory of irrigating ditches.

While by far the most marked change that occurred while these observations were being made is shown in Figures 22 and 23, yet unfortunately comparatively few other drawings were obtained at this time, to indicate to us exactly how it happened. We are more fortunate regarding the minor change exhibited in Figures 5 to 8, 10 and 11, and certain other drawings. In Figures 5 and 10, made December 21 and 25, there are no sharply defined lakes, although in the latter a lake bordering the southern cloud cap is beginning to form. In Figure 11, made December 29, this lake, another preceding it, and Solis Lacus are clearly defined. An unpublished drawing by the writer made the next night confirms the first and last of these, shows Tithonius Lacus forming, and Juventae Fons sharply defined. The southern cloud cap had

entirely disappeared, but there is an indistinct light hazy band of cloud, described as resembling a causeway, in the interior of the *mare*, where the lakes and canals appeared the next night. In Figure 6, made December 31, these lakes and canals are clearly shown, where the previous night, with better seeing 12, none at all were visible. Figure 7, made January 3, shows Solis Lacus and the lake to the north of it identical with Figure 6, but the remaining lakes are all reduced in size, while the anonymous interior one to the south of Auri is replaced by two smaller ones. A drawing by the writer made January 5 shows no trace of Auri or the interior lakes, and this is confirmed by Figure 8 made the next night by Slipher. The most natural explanation seems to be that the lakes were marshes which quickly formed and evaporated under the low atmospheric pressure.

TABLE V.

LAKES RECORDED BY MESSRS. PHILLIPS, PICKERING AND DOUGLASS.

No.	Lake	Pl	Pk	D
1	Acidalius			A
2	Acube			DE
3	Ambrosia L		B	B
4	Anonum L			B
5	Auri L		B	B
6	Bathys L		C	C
7	Juventae		B	BE
8	Lemurum			E
9	Minor L			B
10	Protei L	B		
11	Messeis L	B		
12	Moreh L	D		
13	Niliacus	A		
14	Propontis	D		
15	Triv. Charontis	E		DE
16	Solis	B	BC	BC
17	Syrenius L			C
18	Titanus			D
19	Tithonius		B	B
20	Anonymous		B	
21	"	D		D
22	"	E		E

Table V is arranged like Table III, and gives a list of all the lakes recorded by Messrs. Phillips, Pickering and Douglass. Only Solis Lacus was seen by all three observers, eight lakes were seen by two, and thirteen by a single observer.

In conclusion certain facts stand out as a result of this comparison of drawings of identical regions made under diverse conditions, which should I think be more or less encouraging to the amateur. The first is the high quality of the results obtained by Mr. Phillips under an

English sky, as is indicated not merely by the large number of canals seen, but also by the accuracy of the general detail represented. Moreover, in a note he writes that the seeing was unusually poor at this opposition. Whether he can do equally well relatively to the southern stations, at the next two oppositions, when the canals become narrower, will be a matter of interest.

Another interesting point is the comparison of Figures 19, 16 and 20, made respectively with apertures of 8 and 40 inches. While differing in the style of representation as already mentioned, there is no canal or other feature common to Figures 16 and 20 not shown by Professor Douglass in Figure 19. Outside the dark regions each drawing shows two or three canals peculiar to itself. Within the dark regions Professor Douglass, who specializes on this portion of the planet, shows a number of canals not seen by the others. Regarding the duplication of the canals, Schiaparelli discovered it with an aperture of 8 inches; Douglass declines to admit its existence even when seen with an aperture of 24. One of the main objects of this investigation, as stated in the original circular, was to determine the importance of very large apertures. Dr. Lowell and the writer have always claimed that for the study of bright planetary detail they were of little if any advantage. Thanks to Dr. Lowell's coöperation, I believe that we have proved such to be the case. The proof is more complete than the writer had originally planned, because here we have an expert on Mars at each telescope.

Thirdly it is thought that the public, who have been brought up to believe that the canals of Mars always appeared as straight spider lines, will be a little surprised to find that most of the representations of them show them as broad, hazy and curved bands. Except in curves of great radius they are never sinuous.

Finally, the writer wishes to express the opinion that future observers of Mars should specialize more on the constantly changing details of the larger features of the planet, and devote less time to the very faintest canals. It is believed that our knowledge of life on the planet will be more rapidly advanced by studying those remarkable changes, whether their accomplishment requires days or years, than it will be by mapping one hundred canals, twenty of which are so faint that no other observer can fully corroborate them, and which, even if they are there, are of no particular consequence.

ASTRONOMICAL TEACHING IN THE CITY.

MARY E. BYRD.

[*Continued from page 159.*]

The observations of the sun and moon which have already been considered are about the easiest to make in the city, nor are they by any means lacking in interest for beginners. And yet, alike in city and country, it is the heavens at night, the stars and planets that waken enthusiasm. One of my vivid New York memories is of a young girl, her face all aglow with happiness, just as she had succeeded in identifying a bright planet, seen one winter morning, on her way home from early mass. Another student, when something was said about helping in the department, replied eagerly, "Oh I should enjoy it so much, especially the constellation work." A third, with a little diffidence, but sparkling eyes confided to me, rather as a friend than a teacher, "Why the stars seem to belong to me, when I have found them alone, by myself, up on the roof."

It is well in the city to make much of all that can be done in the daytime, but that need not obscure the fact that the evening observing is the heart of a practical course. Determinations of latitude and time, though made with the solar-image gnomon are hardly complete till the results thus derived have been checked and reënforced by those obtained from the stars. While it may not be practicable with large classes to include such observations in the list of hard and fast requirements for everyone, there are always students who, in spite of adverse conditions, can accomplish much more than the minimum. Having keen eyesight, or what is better, a knack at doing things, they are able to forge ahead, to get sidereal time from the plumb-line transit of stars, and secure data for that problem, dear to the heart of teachers, the determination of latitude from an off-meridian altitude of Polaris.

Practically all study of lunar and planetary motion is evening study. Wherever carried on, it is essential, at a definite time, to locate the moving body carefully in reference to comparison stars, near it, if possible. And here city students meet their crucial difficulty. The stars they can see readily are comparatively few; and it does not often happen that one bright enough for use is found near the given object. Sometimes opera-glasses of low power bring one out, but it is better to place the main dependence upon bright stars, even though they are far away. Eyes can be trained to estimate, with

a fair degree of accuracy, long distances and angles of inconvenient size, and thus positions may be fixed on different nights, from week to week. They should be properly distributed and sufficient in number for plotting the path of the moon and one or two of the bright planets, as they move across the background of the stars.

Though simple and brief in statement, the subject demands patient watching on many nights, and presupposes a thorough knowledge of the constellation. The constellations, "Ay, there's the rub"! In a literal sense, they are fundamental. Barring a few topics, dealing exclusively with the sun, they are the foundation upon which is built practically all naked-eye knowledge of the heavens. Some concession may properly be made to the city sky, the number of constellations mapped may be a little smaller than elsewhere, and the stars fewer in each. There is, however, no alternative, students have simply got to know the constellations. But how can they know them if they cannot see them! The key to the puzzle is the familiar fact that it is fairly easy to pick up a faint object in the sky, when one knows just where to look for it. There must be, then, painstaking preparation before-hand, such as is never dreamed of in favorable localities. The Greek-letter names of the stars must be as familiar, almost as the student's own name. No perfunctory study of star-maps suffices. There should be repeated and persistent drill in their use during laboratory periods, in the daytime. For example, having given two bright stars of a constellation, students should locate five or six others by drawing imaginary lines and laying off imaginary angles, not stopping, by any means, with one reference line or one order of procedure.

Exercises like these train the eyes and familiarize the class with the general method, nor are they likely to bias the judgment in actual observing, where conditions are so dissimilar. Estimating angles and distances on the concave dome of the heavens is a very different thing from making alignments on the flat surface of a star-map. The scale for a single constellation differs from that of the maps, being, as a rule, much larger. The preliminary work, designed to help in finding the stars, has purposely an element of indefiniteness. Thus, an angle is about a right angle, a little more or a little less, not $90^\circ + \frac{1}{10}$ of 90° nor $90^\circ - \frac{1}{8}$ of 45°. And finally and most important, as a safeguard against bias, the order followed in identifying stars is seldom the best to employ in sketching, and one change in the order of placing one star will change nearly every distance and angle. Indeed, identifying the stars and mapping the constellations are two entirely distinct things. In making the drawing, students should work out their own scheme, marked as strongly as possible by their own individuality, taking care

to avoid even an inkling of what others about them are doing. In a word, they are bound by the strictest rules of independence in obtaining and recording all data employed. On the other hand, in finding the stars in the sky, during the first nights of observing, teachers should give help in any and every possible way. They will find that they can almost lend their eyes for others to see with.

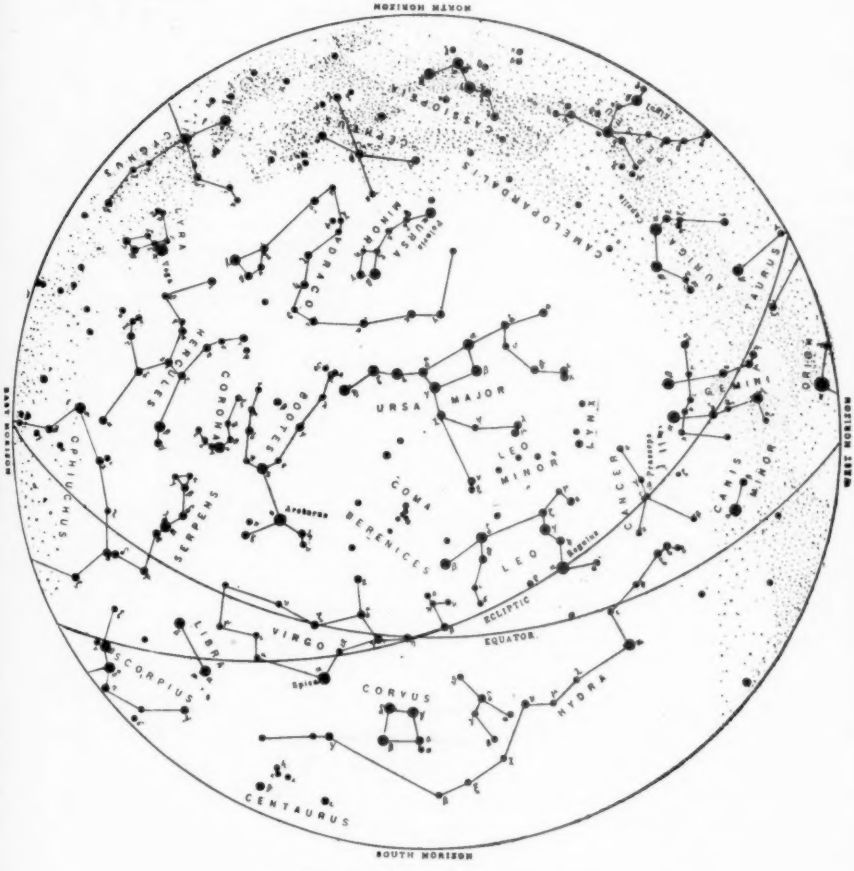
It would, however, be unfair to conclude that all evening observing is a struggle to see. The work at the regular station should invariably be supplemented by that done at parks or other vantage points, somewhat removed from the central glare, and the polluting effects of dust and smoke. The week-end trips reveal a new heaven, where celestial fields are sown thick with stars; and even amid the worst surroundings there come nights when the bright constellations, outlined mainly by first and second magnitude stars, stand out with wonderful distinctness. Those who have patiently watched the "great square of Pegasus" till its lowest star has cleared the neighboring roof, and until Cassiopeia, with slow and stately motion comes into full view between the walls of two buildings, cannot soon forget them. And there are few who do not feel the thrill of contrast between the silent stars overhead and the buzzing hive of humanity below.

Fortunately city teachers have some special advantages. They have no need to be anxious and troubled lest they fall into a dull, mechanical routine. The very conditions under which they work make that almost impossible. Favored instructors, in western New England, near Sunset Hill, may possibly find that their students look upon astronomy as a monotonous affair, just another part of the college grind. City students come to the evening observing as to an adventure. Whatever is done is an achievement. They are not learning lessons, they are conquering difficulties and making discoveries! For them there is no need of constant urging to share their knowledge with others. The injunction, so often given elsewhere, "Be sure and teach some child the constellations" is with them uncalled for. A single student in New York City has been known to bring up a whole family, astronomically. Fathers, mothers, big brothers, little brothers, little sisters, other relatives, sweethearts and friends are presssed into service to aid as chaperons and in many other ways; and they are rewarded by being instructed in constellations and evening stars.

No one, not even an enthusiast, would claim that the city is an ideal place to teach astronomy. But even the city cannot obliterate the friendly stars. From its crowded streets, our students may look up, and name their friends, the planets, and count the proud roll of their constellations.

PLANET NOTES FOR MAY, 1915.

The sun will move northeasterly from the constellation Aries into Taurus during this month. In its course it will pass about three degrees south of the Pleiades and at the end of the month it will be about five degrees north of Aldebaran. This brilliant part of the sky will therefore be invisible in the brightness of the sun during this month.



THE CONSTELLATIONS AT 9:00 P. M. MAY 1.

The phases of the moon for this month are as follows:-

Last Quarter	May	5	at	11 P.M.	C.S.T.
New Moon		13	"	10 P.M.	"
First Quarter		21	"	11 P.M.	"
Full Moon		28	"	4 P.M.	"

Mercury will be in conjunction with the sun, that is, almost directly back of the sun from the earth on the first day of the month. It will move east from the sun during the month and reach a point of greatest eastern elongation on the last day of the month. On and near this date it will set about an hour and forty minutes after the sun at nearly the same point on the horizon as the sun. It will therefore be visible in the west just after sunset at this season. At this time only about half of the illuminated disk will be turned toward the earth, and it will therefore not be very brilliant.

Venus will still be a brilliant object in the southeast at and before sunrise throughout this month. It will be moving northward and eastward slowly toward the sun. Nearly all of its illuminated surface will be turned toward the earth and it will therefore be very bright and conspicuous. It will be in Pisces. It will not be near any bright star.

Mars will be moving across the sky quite close to Venus throughout the month. It will be much fainter than Venus, because of its great distance from the earth. For several months Mars has not been visible at all, and during this month it will still require that those who wish to observe it rise early in the morning.

Jupiter which was quite near to Venus and Mars during April will be left behind because it will be moving eastward more slowly. It will therefore be farther from the horizon than the two mentioned. It will however be easily recognizable because of its great brilliancy. It will not be as brilliant as Venus. It will be in a region of the sky that is free from bright stars.

Saturn will be found lower in the west each day at sunset. At the beginning of the month it may still be observed but at the end of the month it will be quite near the sun.

Uranus will be in quadrature, 90° west of the sun on May 6. At this date it will be on the meridian at sunrise. It may therefore be well observed in the early morning.

Neptune will be well situated for observations in the evening during this month. It will be in the western part of the constellation Cancer.

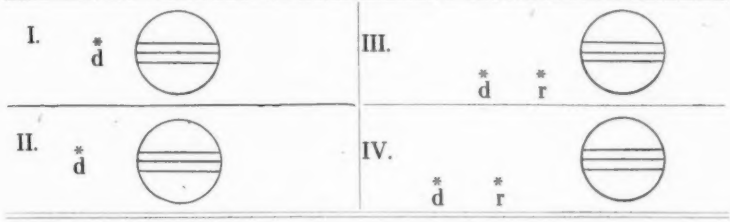
Occultations Visible at Washington.

Date 1915	Star's Name	Magnitude	IMMERSION. Washington M.T.		Angle f'm N.	EMERSION. Washington M.T.		Angle f'm N.	Duration	
			h	m	°	h	m	°	h	m
May 5	*i* Capricorni	4.3	14	29	50	15	40	263	1	11
6	*e* Aquarii	5.4	13	53	62	15	0	249	1	6
18	187 B Gemin.	6.3	11	12	129	11	59	267	0	46
21	A Leonis	4.6	10	38	97	11	32	326	0	54
25	75 Virginis	5.6	12	33	60	13	12	348	0	39
29	10 G Sagittarii	5.7	14	44	22	15	21	322	0	37

Satellites of Jupiter, May 1915.

WASHINGTON MEAN TIME.

Phases of the Eclipses of the Satellites for an Inverting Telescope.



Configurations at 15h 30m for an Inverting Telescope.

Day	West	East
1	·1	○ ·2 ·3 ·4
2		○ 2· ·1 3· 4·
3	·2 ·1	○ 3· 4·
4	3·	○ 1·2 4·
5	3·	○ 4·2· ·1●
6	·3 2· 4· 1·	○
7	4· ·2	○ ·3·1
8	4· ·1	○ ·2 ·3
9	4·	○ 2· ·1 3·
10	·4 2· ·1	○ 3·
11	·4 3·	○ 1· ·2●
12	·4 3· ·1	○ 2·
13	○ 1· 3·4 2·	○
14	·2	4○ ·1 ·3●
15	1·	○ ·2·4 ·3
16		○ 2·1 3· ·4
17	2· 1·	○ 3· ·4
18	3·	○ 1· ·4 ·2●
19	3· ·1	○ 2· 4·
20	·3 2·	○ 1· 4·
21	·2	○ 4· ·1● ·3●
22	1·	○ 4· ·2 ·3
23	4·	○ ·12· 3·
24	4· 2· 1·	○ 3·
25	4· 3·2	○ 1·
26	4· 3· ·1	○ ·2
27	○ 2· ·4 ·3	○ 1·
28	·4 ·2 ·3	♀ ·1●
29	○ 1· ·4	○ ·2 ·3
30	·4	○ ·1 2· ·3
31	2· 1·	○ ·4 3·

VARIABLE STARS.

Approximate Magnitudes of Variable Stars of Long Period on Mar. 1, 1915.

[Communicated by the Director of Harvard College Observatory, Cambridge, Mass.]

Name.	R. A. 1900. h m	Decl. 1900. ° ′	Magn.	Name.	R.A. 1900 h m	Decl. 1900 ° ′	Magn.
X Androm.	0 10.8	+46 27	12.5 *i*	T Can. Min.	7 28.4	+11 58	11.2*d*
T Androm.	0 17.2	+26 26	9.5*d*	U Can. Min.	35.9	+ 8 37	10.7*d*
T Cassiop.	17.8	+55 14	8.5*d*	S Gemin.	37.0	+23 41	13.4*d*
R Androm.	18.8	+38 1	9.0 *i*	T Gemin.	43.3	+23 59	9.9*d*
S Ceti	19.0	— 9 53	8.4	U Puppis	56.1	—12 34	<12.0
U Cassiop.	40.8	+47 43	9.0*d*	R Cancri	8 11.0	+12 2	9.7 *i*
RW Androm.	41.9	+32 8	<11.0	V Cancri	16.0	+17 36	10.8 *i*
V Androm.	44.6	+35 6	9.6 *i*	T Lyncis	16.4	+33 51	9.4*d*
RR Androm.	45.9	+33 50	11.4*d*	U Cancri	30.0	+19 14	13.1
W Cassiop.	49.0	+58 1	8.9	S Hydrae	48.4	+ 3 27	8.3 *i*
Z Ceti	1 1.6	— 2 1	9.0	T Hydrae	50.8	— 8 46	7.9 *i*
S Cassiop.	12.3	+72 5	7.8	W Cancri	9 4.0	+25 39	<13.0
S Piscium	12.4	+ 8 24	12.5*d*	X Hydrae	30.7	—14 15	11.3
RZ Persei	23.6	+50 20	13.2*d*	Y Draconis	31.1	+78 18	13.3*d*
R Piscium	25.5	+ 2 22	10.8*d*	R Leo. Min.	39.6	+34 58	8.4*d*
X Cassiop.	49.8	+58 46	10.0*d*	R Leonis	42.2	+11 54	8.1*d*
U Persei	53.0	+54 20	8.6*d*	V Leonis	54.5	+21 44	10.5*d*
R Arietis	2 10.4	+24 35	9.3 *i*	R Urs. Maj.	10 37.6	+69 18	7.2*d*
o Ceti	14.3	— 3 26	3.6	W Leonis	48.4	+14 15	12.2 *i*
S Persei	15.7	+58 8	10.5	SU Virginis	12 0.0	+12 56	9.3
R Ceti	20.9	— 0 38	8.1	R Corvi	14.4	+18 42	10.8 *i*
RR Persei	21.7	+50 49	12.7 *i*	T Urs. Maj.	31.8	+60 2	9.4*d*
U Ceti	28.9	—13 35	7.0	R Virginis	33.4	+ 7 32	9.2 *i*
R Trianguli	31.0	+33 50	11.6*d*	RS Urs. Maj.	12 34.4	+59 2	10.6 *i*
W Persei	43.2	+56 34	9.6	S Urs. Maj.	39.6	+61 38	11.4
U Arietis	3 5.5	+14 25	7.4	U Virginis	46.0	+ 6 6	7.8
X Ceti	14.3	— 1 26	13.0	S Virginis	13 27.8	— 6 41	8.4*d*
Y Persei	20.9	+43 50	9.2*d*	T Urs. Min.	32.6	+73 56	<11.0
R Persei	23.7	+35 20	8.5 *i*	R Can. Ven.	44.6	+40 2	7.4 *i*
W Tauri	4 22.2	+15 49	12.0	U Urs. Min.	14 15.1	+67 15	8.6
R Tauri	22.8	+ 9 56	<11.0	S Bootis	19.5	+54 16	10.6*d*
X Camelop.	32.6	+74 56	9.0*d*	R Camelop.	25.1	+84 17	11.7*d*
RX Tauri	32.8	+ 8 9	10.8*d*	V Bootis	25.7	+39 18	7.4
V Tauri	46.2	+17 22	10.3*d*	R Bootis	32.8	+27 10	8.8 *i*
R Orionis	53.6	+ 7 59	10.0 *i*	U Bootis	49.7	+18 6	10.2
R Leporis	55.0	—14 57	9.5	S Cor. Bor.	15 17.3	+31 44	7.0
T Leporis	5 0.6	—22 2	10.6*d*	S Urs. Min.	33.4	+78 58	10.2 *i*
V Orionis	0.8	+ 3 58	11.0 *i*	U Herculis	16 21.4	+19 7	10.3 *i*
R Aurigae	9.2	+53 28	9.3*d*	R Draconis	32.4	+66 58	10.8*d*
W Aurigae	20.1	+36 49	<12.0	S Herculis	47.4	+15 7	11.2 *i*
U Aurigae	35.6	+31 59	<12.0	RV Herculis	56.8	+31 22	12.0*d*
SU Tauri	43.2	+19 2	10.0*d*	RU Ophiuchi	17 28.1	+ 9 30	12.0*d*
RU Tauri	46.9	+15 57	12.8	T Draconis	54.8	+58 14	11.2
V Camelop.	49.4	+74 30	<13.0	W Lyrae	18 11.5	+36 38	8.5*d*
U Orionis	49.9	+20 10	9.6 *i*	RT Cygni	19 40.8	+48 32	9.0 *i*
X Aurigae	6 4.4	+50 15	10.3*d*	χ Cygni	46.7	+32 40	8.2*d*
U Lyncis	31.8	+59 57	<13.0	U Cygni	20 16.5	+47 35	9.7*d*
S Lyncis	35.9	+58 0	9.8	T Cephei	21 8.2	+68 5	8.8*d*
X Gemin.	40.7	+30 23	8.8	S Cephei	36.5	+78 10	10.5*d*
Y Monoc.	51.3	+11 22	11.3 *i*	S Lacertae	22 24.6	+39 48	8.7*d*
X Monoc.	6 52.4	— 8 56	8.5*d*	R Lacertae	38.8	+41 51	10.0*d*
R Lyncis	53.0	+55 28	7.8 *i*	R Pegasi	23 1.6	+10 0	10.6*d*
R Gemin.	7 1.3	+22 52	11.6*d*	V Cassiop.	7.4	+59 8	7.9 *i*
R Can. Min.	3.2	+10 11	11.0	ST Androm.	33.8	+35 13	11.2
V Gemin.	17.6	+13 17	<12.0	R Cassiop.	53.3	+50 50	9.9*d*
S Can. Min.	27.3	+ 8 32	7.9*d*	SV Androm.	59.2	+39 33	13.0

The letter *i* denotes that the light is increasing; the letter *d*, that the light is decreasing; the sign $<$, that the variable is fainter than the appended magnitude.

The above magnitudes have been compiled at the Harvard College Observatory from observations made by the following observers:—H. C. Bancroft, Jr., T. C. H. Bouton, A. B. Burbeck, H. O. Eaton, F. H. Hay, G. L. Harrell, S. C. Hunter, J. B. Lacchini, C. B. Lindsley, O. Mach, C. Y. McAteer, C. S. Mundt, W. T. Olcott, D. B. Pickering, C. Richter, F. H. Spinney, H. M. Swartz, H. W. Vrooman, I. E Woods, and A. S. Young.

Minima of Variable Stars of Short Period.

[Calculated by Elva Utzinger and C. D. Hibbard at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard 6^h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1915 May
	h m	° ′		d h	d h d h d h d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8	7 0;
RT Sculptor.	31.5	−26 13	9.6—10.5	0 12.3	1 14; 9 6; 16 23; 24 15
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	4 10; 11 21; 19 7; 26 18
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	5 23; 13 10; 20 22; 28 9
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	6 23; 13 2; 19 4; 31 10
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	1 5; 8 8; 15 12; 29 19
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	7 20; 14 17; 21 13; 28 10
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	2 20; 10 1; 17 5; 31 13
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	6 7; 15 2; 23 21
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	6 20; 14 19; 22 17; 30 16
RX Cassiop.	58.8	+67 11	8.6— 9.1	32 07.6	27 18
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	6 6; 12 0; 23 11; 29 4
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	3 11; 10 6; 17 1; 30 15
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	3 7; 11 5; 19 2; 27 0
RW Tauri	3 57.8	+27 51	7.1—$<$11	2 18.5	5 13; 13 20; 22 4; 30 11
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	8 17; 16 15; 24 12
RW Persei	13.3	+42 04	8.8—11.0	15 04.8	7 6; 20 11
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	7 18; 17 5; 26 15
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	12 12; 24 22
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	7 5; 13 21; 20 13; 27 5
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	2 17; 8 4; 19 2; 29 23
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	5 13; 11 13; 23 14; 29 14
SU Tauri	45.8	+28 05	9.4—11.0	2 04.0	6 21; 15 13; 24 5
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	9 12; 19 22; 30 8
SV Gemin.	54.6	+24 28	9.8—$<$11	4 00.2	7 21; 15 22; 23 22; 31 22
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	2 20; 8 14; 20 1; 31 12
U Columbae	6 11.2	−33 03	9.2—10.0	2 19.2	5 19; 11 10; 22 15; 28 5
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	1 15; 9 20; 18 1; 26 6
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	5 15; 13 6; 20 21; 28 12
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	1 5; 13 10; 25 15
RU Monoc.	6 49.4	− 7 28	9.8—10.5	0 21.5	1 8; 8 12; 22 20; 30 0
R Can. Maj.	7 14.9	−16 12	5.8— 6.4	1 03.3	1 19; 10 21; 19 23; 29 1
RY Gemin.	21.7	+15 52	8.9—$<$10	9 07.2	1 11; 10 18; 20 2; 29 9
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	12 1; 21 23; 31 21
TX Gemin.	30.3	+17 8	10.0—11.9	2 19.2	3 5; 11 15; 20 0; 28 10
RR Puppis	43.5	−41 08	9.4—10.7	6 10.3	4 12; 10 23; 23 19; 30 5
V Puppis	7 55.4	−48 58	4.1— 4.8	1 10.9	2 23; 10 5; 17 12; 24 18
X Carinae	8 29.1	−58 53	7.9— 8.7	0 13.0	5 18; 13 21; 22 0; 30 3
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	6 6; 15 17; 25 5
RX Hydrae	9 0.8	− 7 52	9.1—10.5	2 6.8	9 5; 18 8; 27 11
S Antliae	27.9	−28 11	6.3— 6.8	0 07.8	4 5; 10 16; 23 16; 30 3
S Velorum	29.4	−44 46	7.8— 9.3	5 22.4	4 11; 10 9; 22 6; 28 4
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	7 23; 16 9; 24 19
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	3 15; 12 22; 22 4; 31 11
SS Carinae	10 54.2	−61 23	12.2—12.8	3 07.2	5 9; 11 23; 25 4; 31 19
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	4 14; 13 10; 22 5; 31 0
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	3 14; 10 22; 18 6; 25 14
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	3 14; 10 9; 23 23; 30 18

Minima of Variable Stars of Short Period—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1915 May
	h m	° ′		d h	d h d h d h d h d h
RZ Centauri	12 55.6	−64 05	8.5— 8.9	1 21.0	3 15; 11 3; 18 15; 26 3
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	6 2; 13 13; 20 23; 28 10
δ Librae	14 55.6	− 8 07	4.8— 6.2	2 07.9	7 1; 14 1; 21 0; 28 0
U Coronae	15 14.1	+32 01	7.6— 8.7	3 10.9	3 9; 10 6; 24 2; 31 0
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.4	6 2; 14 12; 22 22; 31 8
SS Librae	15 43.4	−15 14	9.3—11.5	0 18.4	1 2; 8 18; 24 2; 31 17
SW Ophiuchi	16 11.1	− 6 44	9.2—10.0	2 10.7	3 21; 11 6; 18 14; 25 22
SX Ophiuchi	12.6	− 6 25	10.5—11.2	2 01.5	5 14; 13 20; 22 2; 30 8
R Arae	31.1	−56 48	6.8— 7.9	4 10.2	9 12; 18 8; 27 4
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	5 0; 16 1; 25 18
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	6 18; 13 13; 20 8; 27 3
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	1 21; 10 6; 18 16; 27 1
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	2 0; 8 3; 20 11; 26 14
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	7 13; 14 18; 21 23; 29 4
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	5 19; 13 4; 20 13; 27 22
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	4 6; 12 11; 20 15; 28 19
TX Scorpii	48.6	−34 13	7.5— 8.2	0 22.6	2 9; 9 22; 17 11; 25 0
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	3 11; 11 5; 18 22; 26 16
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	2 16; 10 16; 18 16; 26 15
WX Sagittae	53.6	−17 24	9.2—10.8	2 03.1	2 13; 11 1; 19 14; 28 2
WY Sagittae	17 54.9	−23 1	9.5—10.6	4 16.0	2 11; 11 19; 21 3; 30 11
SX Draconis	18 03.0	+ 58 23	9.3—10.5	5 04.1	9 0; 19 8; 29 17
RS Sagittarii	11.0	−34 08	5.9— 6.3	2 10.0	7 3; 14 8; 21 14; 28 20
V Serpentis	11.1	−15 34	9.5—11.1	3 10.9	7 14; 14 12; 21 9; 28 7
RZ Scuti	21.1	− 9 15	7.4— 8.3	15 03.2	5 0; 20 3
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	6 7; 14 14; 22 20; 31 2
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	4 14; 13 11; 22 9; 31 6
SX Sagittarii	39.7	−30 36	8.7— 9.8	2 01.8	5 11; 13 18; 22 2; 30 9
RR Draconis	40.8	+62 34	9.3—13	2 19.9	1 8; 9 19; 18 7; 26 19
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	1 10; 8 2; 21 9; 28 0
β Lyrae	46.4	+33 15	3.4— 4.1	12 21.8	6 14; 19 12
U Scuti	18 48.9	−12 44	9.1— 9.6	0 22.9	9 1; 18 14; 28 4
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	6 6; 13 20; 21 10; 28 23
RV Lyrae	12.5	+32 15	11. —12.8	3 14.4	6 20; 14 1; 21 5; 28 10
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	6 6; 15 5; 24 4
U Sagittae	14.4	+19 26	6.5— 9.0	3 09.1	4 14; 11 8; 24 21; 31 15
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	4 10; 11 19; 19 3; 26 12
TT Lyrae	24.3	+41 30	9.3—11.6	5 05.8	1 7; 6 12; 17 0; 27 12
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	1 15; 8 3; 21 4; 27 17
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	3 2; 9 2; 21 2; 27 2
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	6 4; 12 19; 19 10; 26 1
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	4 2; 13 6; 22 9; 31 13
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	4 19; 13 5; 21 16; 30 2
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	2 14; 9 9; 16 4; 29 18
UW Cygni	19.6	+42 55	10.5—13	3 10.8	7 7; 14 5; 21 3; 28 0
V Vulpec.	32.3	+26 15	8.2—9.8	37 19.0	25 21
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	7 4; 16 18; 26 9
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	3 1; 12 5; 21 10; 30 15
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	6 13; 14 1; 21 12; 29 0
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	5 9; 11 5; 17 2; 28 18
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	2 15; 12 17; 22 20
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	5 12; 12 21; 20 6; 27 15
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	9 22; 19 15; 29 7
RY Aquarii	14.8	−11 14	8.8—10.4	1 23.2	3 16; 11 13; 19 10; 27 7
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	9 4
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7	3 15; 13 18; 23 22
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	4 11; 14 20; 25 5; 30 9
X Lacertae	22 45.0	+55 54	8.2— 8.6	5 10.6	5 20; 11 7; 22 4; 27 15
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.3	6 22; 15 5; 23 12; 31 19
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	8 5; 15 18; 23 7; 30 20
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	6 8; 14 13; 22 19; 31 1

Maxima of Variable Stars of Short Period.

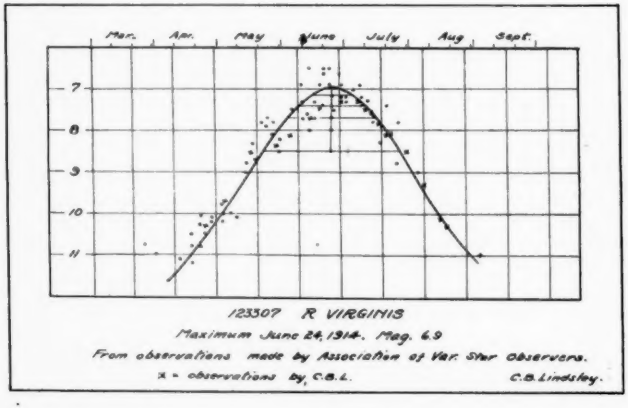
[Calculated by Julia M. Hawkes and Agnes E. Wells at Goodsell Observatory.]

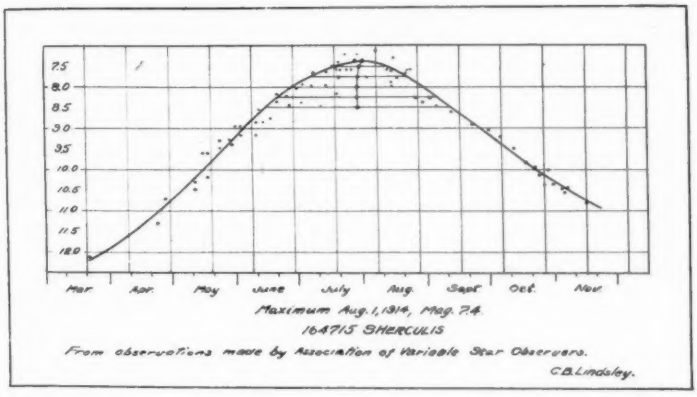
Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5h; Central standard time 6h; etc.

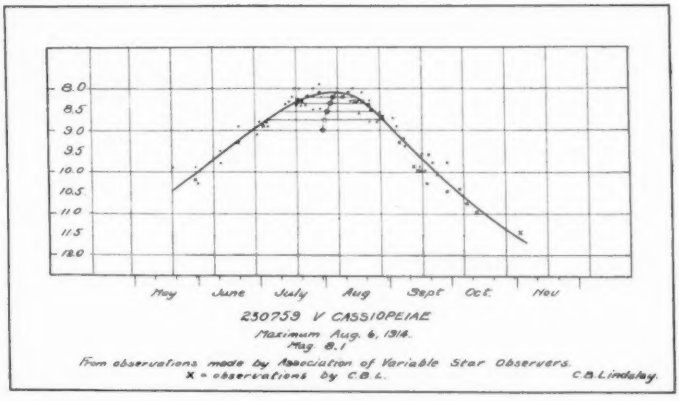
Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1915. May.							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.4	36 13.7								
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	4 4;	12 8;	20 11,	28 14				
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	2 12;	10 6;	18 0;	25 17				
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2		11 7;	26 2					
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	5 6;	13 5;	21 4;	29 2				
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	2 2;	9 21;	17 16;	25 11				
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	7 10;	14 17;	22 0;	29 7				
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	7	23						
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	7 12;	16 2;	24 6					
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	6 1;	17 4;	28 7					
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0		11 4;	22 19					
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	7 15;	15 7;	22 23;	30 15				
SY Aurigae	05.5	+42 41	8.4— 9.5	10 03.3	3 2;	13 5;	23 8					
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	4 14;	12 7;	20 0;	27 17				
RZ Gemin.	5 56.6	+22 12	9.1—10.0	5 12.7	5 20;	11 8;	22 10;	27 22				
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	2 6;	9 20;	17 10;	24 23				
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3		9 14						
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	2 16;	9 20;	24 6;	31 11				
W Gemin.	6 29.2	+15 24	6.7— 7.5	7 22.0	2 8;	10 6;	18 4;	26 2				
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	3 19;	13 23;	24 3					
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	8 11;	30 17						
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	3 8;	11 6;	19 5;	27 4				
V Carinae	8 26.7	−59 47	7.4— 8.1	6 16.7	5 21;	12 14;	19 7;	25 23				
T Velorum	8 34.4	−47 01	7.6— 8.5	4 15.3	8 22;	18 5;	27 12					
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	7 3;	15 21;	24 15					
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 0.0								
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	1 17;	8 11;	15 6;	28 20				
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	3 17;	10 7;	23 12;	30 3				
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	2 14;	12 6;	21 22;	31 13				
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	4 18;	12 18;	20 17;	28 16				
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	4 19;	11 12;	18 6 ;	31 17				
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	1 6;	12 21;	24 13;	30 9				
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	3 23;	13 8;	22 17;	27 10				
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5		17 16						
SS Hydrae	25.0	−23 08	7.4— 8.1	8 4.8	8 0;	16 5;	24 10					
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	2 15;	9 16;	23 17;	30 17				
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	4 20;	13 1;	21 6;	29 11				
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	5 20;	11 8;	22 8;	27 20				
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	2 9;	9 22;	17 11;	25 0				
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	5 9;	12 19;	20 5;	27 15				
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	2 20;	9 15;	23 4;	29 23				
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	1 8;	7 16;	14 0;	26 15				
S Normae	16 10.6	−57 39	6.6— 7.6	9 18.1		9 9;	19 3;	28 21				
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	5 0;	13 21;	22 17;	31 14				
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	3 11;	9 12;	21 15;	27 17				
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	4 9;	11 9;	18 10;	25 10				
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9	9 9;	26 12						
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	2 20;	10 10;	18 0;	25 14				
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	1 4;	6 23;	18 12;	30 1				
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	2 21;	9 15;	23 3;	29 21				
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3	3 15;	13 23;	24 7					
Y Lyrae	34.2	+43 52	11.3—12.3	0 12.1	4 7;	10 8;	22 9;	28 10				
RZ Lyrae	39.9	+32 42	9.9—11.2	0 12.3	4 3;	10 6;	22 13;	28 16				

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1915. May.							
	h m	° ′		d h	d	h	d	h	d	h	d	h
RT Scuti	18 44.1	−10 30	9.1— 9.7	0 11.9	1	16;	7	14;	19	12;	31	9
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	2	17;	11	19;	20	21;	29	23
U Aquilae	19 24.0	− 7 15	6.2— 6.9	7 00.6	3	21;	10	21;	24	22;	31	23
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	5	8;	12	8;	19	8;	26	8
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	6	5;	14	4;	22	4;	30	3
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	6	18;	14	11;	22	3;	29	20
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	7	18;	14	22;	22	2;	29	6
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	1	7;	9	17;	18	2;	26	11
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	5	14;	11	22;	18	6;	30	22
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3			10	5;	26	14		
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	4	23;	13	20;	22	17;	31	14
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	5	19;	12	13;	19	6;	26	0
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	5	19;	12	12;	19	5;	25	22
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	3	8;	18	2				
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	4	19;	12	16;	20	13;	28	9
SW Aquarii	10.2	— 0 20	9.9—10.8	0 11.0	5	8;	12	6;	19	3;	26	0
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	4	0;	8	21;	18	14;	28	7
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	8	6;	16	21;	25	13		
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	2	19;	13	13;	24	6;	29	15
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1			11	16;	22	13		
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	4	16;	11	2;	23	23;	30	9
V Lacertae	22 44.5	+55 48	8.2— 8.9	4 23.6	5	0;	15	0;	24	23;	29	22
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	3	16;	14	13;	25	11;	30	21
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	1	12;	7	19;	20	9;	26	17
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	3	0;	15	3;	27	7		
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	4	9;	14	8;	24	7;	29	7







Variation of α Orionis.—I would like to call your attention to α Orionis (Betelgeuse) which has declined slightly within the past three weeks or so. For nearly two years it has been steady and normal, about a quarter of a magnitude fainter than Rigel, and fifteen hundredths brighter than Aldebaran. It is now only slightly superior to Aldebaran. I have given Betelgeuse much attention for the past five or six years. There was a very pronounced minimum February 14-February 20, 1911. Variable star observers will undoubtedly be interested in this.

F. E. SEAGRAVE.

Boston, March 5, 1915.

COMET AND ASTEROID NOTES.

Comet 1915 *a* (Mellish).—This comet turns out, like Delavan's 1913 *f*, to have been caught while far out from the sun, the distance on February 13 being more than twice that of the earth from the sun. It is coming in rapidly and will reach perihelion about July 20, when its distance from the sun will be just a little more than that of the earth. It will pass nearest the earth about the middle of June when it will be something like 40,000,000 miles away, and its brightness will then be more than a hundred times that at the time of discovery. It may possibly become a conspicuous naked-eye object. At this time, unfortunately for northern observers it will be too far south to be observed in our latitude. It will be most favorably situated for our study in May.

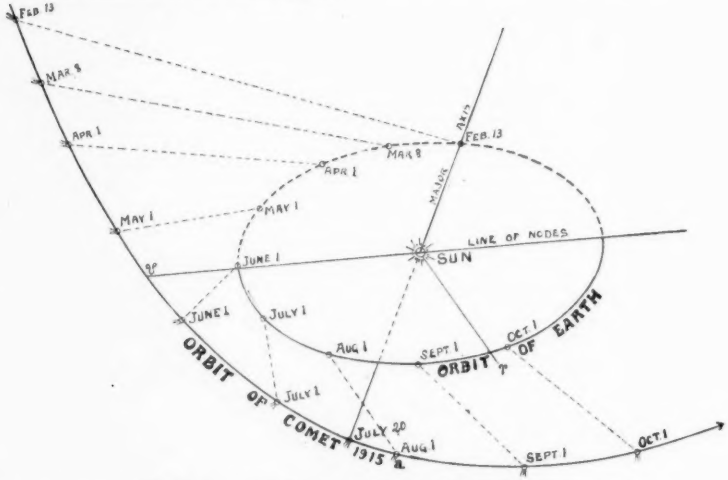


DIAGRAM OF THE ORBIT OF COMET 1915 *a* (MELLISH)

The accompanying diagram shows the relation of the comet's orbit to that of the earth. The planes of the two orbits are inclined at an angle of 53° to each other. The comet will pass through the plane of the ecliptic, at the descending node ☋, about the middle of May. This diagram was prepared by means of the elements given below by Professor Crawford and Miss Young.

During April the course of the comet will be almost directly southeast through the tail of Serpens and Scutum Sobieskii. On April 11 it will be about a half degree south of the star η Serpentis, and for two or three days before and after that date may easily be found by sweeping in the vicinity of that star.

Elements and Ephemeris of Comet *a* 1915 (Mellish).—The results given below were obtained from the following observations:

1915 Gr. M.T.	Comet's Apparent α	δ	Observer
	h m s	° ′ ″	
Feb. 13.0619	17 06 01.9	+2 59 01	Aitken
Feb. 16.9862	17 11 01.6	2 40 55	Wilson, Northfield
Feb. 27.01932	17 23 43.72	+1 54 50.2	Aitken

ELEMENTS

$T = 1915$ July 20.5518 Gr. M. T.
$\omega = 244° 25' 44''$
$\Omega = 73 \ 39 \ 16$ } 1915.0
$i = 53 \ 28 \ 28$
$\log q = 0.031461$

(O—C)	I	III
$\cos\delta\,\Delta\alpha$	0″	+2″
$\Delta\delta$	+16	+1

The large residual in the first declination is due either to accumulated errors of observation or actual deviation from parabolic motion.

CONSTANTS FOR THE EQUATOR 1915.0

$$x = r\,[9.803934]\sin(\ 38\ 11\ 48 + v)$$
$$y = r\,[9.952243]\sin(345\ 06\ 55 + v)$$
$$z = r\,[9.949374]\sin(269\ 50\ 18 + v)$$

EPHEMERIS FOR GREENWICH MEAN MIDNIGHT

1915	True α	True δ	log Δ	Br.
	h m s	° ′ ″		
Mar. 5.5	17 31 52.6	+ 1 23 24	0.3483	1.79
6.5	33 07.6	18 22		
7.5	34 22.5	13 15		
8.5	35 37.3	08 04		
9.5	36 52.0	1 02 49	0.3294	2.04
10.5	38 06.6	0 57 29		
11.5	39 21.1	52 03		
12.5	40 35.4	46 32		
13.5	41 49.7	40 55	0.3096	2.33
14.5	43 03.8	35 11		
15.5	44 17.9	29 21		
16.5	45 31.8	23 23		
17.5	46 45.7	17 17	0.2888	2.67
18.5	47 59.4	11 02		
19.5	49 12.9	+ 0 04 39		
20.5	50 26.3	— 0 01 53		
21.5	51 39.7	08 36	0.2671	3.08
22.5	52 52.9	15 29		
23.5	54 06.0	22 33		
24.5	55 19.0	29 49		
25.5	56 31.9	37 18	0.2442	3.58
26.5	57 44.7	45 00		
27.5	17 58 57.4	0 52 56		
28.5	18 00 10.0	1 01 06		
29.5	01 22.6	09 32	0.2202	4.19
30.5	02 35.1	18 14		
Mar. 31.5	03 47.5	27 13		
Apr. 1.5	04 59.8	36 31		
2.5	06 12.1	46 07	0.1950	4.92
3.5	07 24.3	1 56 03		
4.5	08 36.5	2 06 20		
5.5	09 48.7	16 59		
6.5	11 00.8	28 01	0.1683	5.84
7.5	12 12.9	39 28		
8.5	13 24.9	2 51 20		
9.5	14 37.0	3 03 40		
10.5	18 15 49.0	—3 16 29	0.1402	6.98

1915	True α h m s	True δ ° ′ ″	log Δ	Br.
Apr. 11.5	18 17 01.0	−3 29 48		
12.5	18 13.1	43 39		
13.5	19 25.2	3 58 04		
14.5	20 37.4	4 13 04	0.1105	8.41
15.5	21 49.7	28 42		
16.5	23 02.0	4 44 59		
17.5	24 14.5	5 01 58		
Apr. 18.5	18 25 27.1	−5 19 41	0.0790	10.22

Brightness February 13 = 1.00.

It is to be noted that the comet is approaching both the Earth and the Sun. The closest approach to the Earth will be about the middle of June, when its distance will be only a little more than four-tenths of an astronomical unit. At this time the brightness will be 165 times greater than at discovery. By the first of June the comet will be too far south to be seen from this latitude. It should be a very conspicuous object for those south of the equator during the month of June.

A first preliminary orbit was computed from the first two of the observations given above, and a third by Aitken made February 14. The elements of this orbit are:

$$\left.\begin{aligned} T &= 1915\ \text{Aug. } 2.39\ \text{Gr. M. T.} \\ \omega &= 225^\circ\ 54' \\ \Omega &= 79\ 28 \\ i &= 48\ 37 \end{aligned}\right\} \quad 1915.0$$
$$\log q = 0.17462$$

An investigation of the computation showed that but one significant number was known in the quantities upon which the solution for the geocentric distance depends, and that, therefore, the value of this distance at the middle date could range anywhere from 2.0 to 4.5. The solution actually gave 2.83. This preliminary orbit, together with a four-place ephemeris, was telegraphed to Harvard College Observatory.

The new orbit gives 2.69 for the value of the geocentric distance at the middle date of the first orbit, which falls within the range of solution established for the first orbit.

R. T. Crawford,
Jessica M. Young.

Berkeley Astronomical Department,
March 2. 1915.
Lick Observatory Bulletin, No. 268

Ephemeris of Encke's Comet at Opposition in 1916.—In the December 1914 number of Popular Astronomy Professor Barnard of the Yerkes Observatory has an interesting article on Encke's comet. After mentioning the discovery of the comet by photography at the Yerkes Observatory and refering to previous apparitions of the comet, he mentions a photograph taken of the region where the comet was on September 1, 1913. The last aphelion passage of the comet took place on April 12, 1913, so that the photograph was taken only 142 days after aphelion passage. Prof. Barnard says that the suspicious object on the plate taken on September 1, 1913 is so easily seen that, if it proves to be the comet, there will be "no trouble whatever in photographing it in any part of its orbit." The enclosed elements are for the next return in 1918. The constants (x, y, z) are based upon those elements. The next aphelion passage will take place on July 29.21 G.

M. T. 1916. The enclosed Ephemeris was computed in hopes that the comet might be photographed at exactly the time of Aphelion passage, as it will be favorably situated, coming to the meridian about two and a half hours after midnight and will be on a dark sky as the moon will at that time be well out of the way.

F. E. SEAGRAVE.

Boston, Mass., March 13, 1915.

ELEMENTS OF ENCKE'S COMET FOR NEXT RETURN IN 1918, AND EPHEMERIS OF SAME FOR TIME OF APHELION IN 1916.

$T = 1918$ March 23.510 G. M. T.
$\phi = 57^\circ\ 56'\ 12''.72$
$\Omega = 334\ 32\ 10\ .47$
$\pi = 159\ 10\ 40\ .01$
$i = 12\ 34\ 55\ .91$
$\log a = 0.345428$
$\log q = 9.52878$
$\mu = 1076''.11295$

Next aphelion 1916 July 29.21 G. M. T.

$x = r\,[9.99808] \sin(65^\circ\ 4'\ 26'' + u)$
$y = r\,[9.91510] \sin(331\ 20\ 34 + u)$
$z = r\,[9.76080] \sin(342\ 44\ 8 + u)$

1916 Greenwich	α h m s	δ ° ′ ″	$\log r$	$\log \Delta$
July 13	23 23 50	−2 48 4	0.61180	0.53975
17	23 22 46	−2 51 15	0.61190	0.53496
21	23 20 57	−2 58 27	0.61196	0.52849
25	23 18 47	−3 8 8	0.61200	9.52224
29	23 15 57	−3 21 37	0.61200	0.51555
Aug. 2	23 13 43	−3 31 32	0.61200	0.51088
6	23 10 48	−3 45 42	0.61196	0.50585
10	23 7 40	−4 1 10	0.61188	0.50133
14	23 4 20	−4 17 54	0.61178	0.49740
18	23 0 48	−4 35 44	0.61168	0.49409

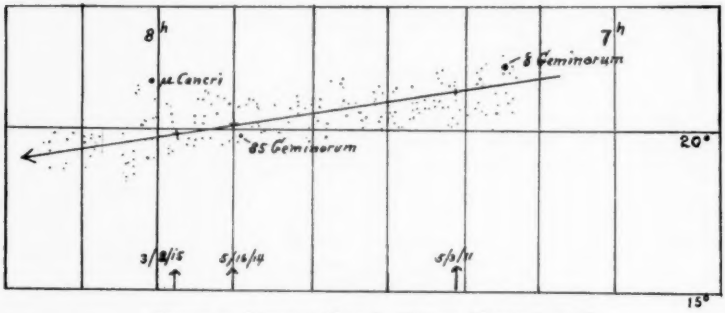
Continuation of Ephemeris of Comet 1915 *a* (Mellish).

[Computed by Miss J. M. Hawkes and Miss Elva G. Utzinger, from the elements given on page 243.]

1915	True α h m s	True δ ° ′ ″	$\log \Delta$	Br.
Apr. 18.5	18 25 25.0	−5 19 26	0.0790	10.22
19.5	26 37.8	37 56		
20.5	27 50.8	5 57 15		
21.5	29 04.0	6 17 26		
22.5	30 17.7	6 38 32	0.0456	12.55
23.5	31 31.5	7 00 37		
24.5	32 45.8	23 42		
25.5	34 00.5	7 47 52		
26.5	35 15.6	8 13 10	0.0102	15.56
27.5	36 31.4	8 39 40		
28.5	37 47.8	9 07 27		
29.5	39 04.8	9 36 36		
30.5	40 22.6	10 07 10	9.9726	19.52
May 1.5	41 41.3	10 39 16		
2.5	43 00.9	11 12 59		
3.5	44 21.5	11 48 25		
4.5	18 45 43.2	−22 25 39	9.9327	24.76

NOTES FOR OBSERVERS.

Neptune.—Now that the planet Neptune is so well located for observation, it may be that many telescopists with glasses unequipped with circles would like to observe the movement of this remote member of the solar system. To facilitate a search for Neptune the accompanying sketch, showing the faint stars in the imme-



COURSE OF NEPTUNE MAY 3, 1911 TO MARCH 8, 1915.

diate vicinity of the planet, may be of service. It is traced from the Harvard College Observatory photographic map of the heavens, which reveals stars as faint as the eleventh magnitude.

During February Neptune retrogrades, and should be swept for between 85 Geminorum and a point midway between μ and ζ Cancri. The planet is a trifle brighter than the eighth magnitude. On the map the crosses indicate the position of the planet on the designated dates.

W. T. OLCOTT

Monthly Report of the American Association of Variable Star Observers, Feb.-Mar., 1915.

It is a pleasure to announce that Professor G. L. Harrell, (Hr), Director of James Observatory, Millsaps College, Jackson, Miss., has joined the Association. Professor Harrell observes with a 6″ Brashear equatorial, and because of his southern location is able to render a valuable service by observing variables necessarily much neglected.

Members will be glad to learn that Dr. Gray's health is rapidly improving, and that Mr. Bancroft has resumed his place among the active observers.

Mr. C. B. Lindsley deserves our gratitude for his generous contributions of blue prints for distribution. The curves published by Mr. Lindsley in the March issue of POPULAR ASTRONOMY were of exceptional merit and a credit to the Association.

Now that affairs abroad are in such a sad state of strife and turmoil, and the science of warfare has stifled all progress in the ennobling branches of science, a greater responsibility is imposed on us to persist in our efforts to accumulate consistently an ever increasing amount of data, and to see to it that the continuity in any series of observations is preserved. It is especially important that the irregular variables be observed at every opportunity, in order that no maximum pass unobserved if possible, as all data concerning these erratic variables is of the utmost value and importance.

VARIABLE STAR OBSERVATIONS Feb.-Mar. 1915.

001046
X Androm.

Mo.	Day	Est.	Obs.
2	12	13.3	B
	20	13.0	Ba

001726
T Androm.

Mo.	Day	Est.	Obs.
2	3	8.9	Ly
	3	8.3	R
	4	8.7	Bu
	4	8.5	S
	4	8.3	R
	5	8.3	R
	6	8.3	R
	7	8.9	Ly
	7	8.3	R
	9	8.6	V
	9	9.1	O
	10	9.0	Ly
	13	8.3	R
	13	9.1	Ly
	17	9.3	Ly
	20	9.0	Ba

001755
T Cassiop.

Mo.	Day	Est.	Obs.
2	3	9.4	R
	4	8.6	S
	4	9.8	Bu
	4	9.2	R
	5	9.1	R
	6	8.9	R
	7	8.7	R
	9	8.1	B
	9	9.7	M
	13	8.1	O
	13	8.8	R
	18	7.9	O
	19	7.8	B
3	4	8.5	S

001838
R Androm.

Mo.	Day	Est.	Obs.
2	4	9.2	Bu
	10	10.8	Ly
	12	10.1	B
	14	9.5	Hy
	17	9.7	Ly
	19	9.4	Hu
	20	10.0	Ba

001909
S Ceti

Mo.	Day	Est.	Obs.
2	3	8.7	R
	4	8.8	R
	4	8.2	Bu
	5	8.7	R
	6	8.8	R
	7	8.9	R
	13	8.9	R

003179
Y Cephei

Mo.	Day	Est.	Obs.
2	20	10.6	Ba

004047
U Cassiop.

Mo.	Day	Est.	Obs.
2	4	8.4	Bu
	4	8.6	S
	9	8.6	B
	17	9.9	L
	19	8.9	B

004435
V Androm.

Mo.	Day	Est.	Obs.
2	4	10.9	O
	12	10.6	B
	17	9.9	O

004746
RV Cassiop.

Mo.	Day	Est.	Obs.
1	10	12.5	L

004958
W Cassiop.

Mo.	Day	Est.	Obs.
2	8	9.3	B
	9	10.5	M
	10	9.3	Y
	13	9.7	O
	19	9.1	B
	20	9.4	Ba
	28	9.0	Ba

010102
Z Ceti

Mo.	Day	Est.	Obs.
2	13	9.7	Y

011208
S Piscium

Mo.	Day	Est.	Obs.
2	4	11.7	B
	13	12.2	Y

011272
S Cassiop.

Mo.	Day	Est.	Obs.
2	3	8.9	R
	4	8.7	Bu
	4	9.0	R
	5	9.1	R
	6	9.1	R
	7	9.2	R
	7	8.5	Ly
	9	8.2	Ma
	9	7.8	M
	9	8.4	B
	10	8.4	Ly
	13	8.8	R
	15	8.5	Ly
	17	8.3	Ly
	19	8.0	O
	19	7.8	B
	22	7.9	Ly
	28	7.9	M
	28	7.5	Ba
3	9	8.4	O

012350
RZ Persei

Mo.	Day	Est.	Obs.
2	4	12.0	Hr
	16	13.0	Hr
	23	13.0	Hr

012502
R Piscium

Mo.	Day	Est.	Obs.
2	3	9.7	R
	4	10.2	Bu
	4	10.0	R
	5	10.0	R
	6	10.0	R
	7	10.5	R
	13	10.6	R
	14	10.2	Hy

014958
X Cassiop.

Mo.	Day	Est.	Obs.
2	8	9.5	B
	9	10.4	Bu
	10	9.3	Y
	19	9.4	B
	28	9.2	Ba

015254
U Persei

Mo.	Day	Est.	Obs.
2	3	9.0	R
	4	9.1	R
	5	9.1	R
	6	8.9	R
	7	9.1	R
	9	8.3	B
	9	8.0	V
	9	9.4	Bu
	10	8.3	Ly
	13	8.9	R
	15	8.0	Ly
	17	8.1	Ly
	19	8.1	B
	28	8.1	Ba

021024
R Arietis

Mo.	Day	Est.	Obs.
2	9	10.0	Bu
	10	10.1	Ly
	13	10.3	O
	17	10.0	Pi
	17	10.2	O
	20	9.3	Ba

021403
o Ceti

Mo.	Day	Est.	Obs.
12	23	5.4	L
	27	5.2	L
1	4	4.1	L
	10	3.8	L
	12	3.7	L
	30	3.5	L
2	3	3.7	R
	4	3.8	R
	5	3.6	R
	6	3.5	R
	7	3.5	R
	8	3.5	Mu
	8	3.2	Pi
	9	4.0	Ly
	9	3.8	Bu
	10	3.5	L
	10	3.9	Ly

o Ceti

Mo.	Day	Est.	Obs.
2	10	3.9	O
	10	3.4	Mu
	11	3.4	Mu
	12	4.0	O
	12	3.5	Mu
	13	3.6	Mu
	13	3.9	O
	13	3.7	R
	14	3.9	Ly
	14	4.5	St
	16	3.8	Ma
	17	3.9	O
	17	3.7	L
	20	3.6	Mu
	20	4.0	O
	22	3.9	Ly
3	8	4.3	O

021658
S Persei

Mo.	Day	Est.	Obs.
2	3	10.8	R
	4	10.8	R
	5	10.7	R
	6	10.8	R
	7	10.7	R
	9	9.6	B
	9	10.5	Ly
	9	10.2	Bu
	10	10.9	Ly
	13	10.6	R
	15	10.6	Ly
	17	10.4	Ly
	19	9.7	B
	20	10.4	Ba
	9	10.5	O

022000
R Ceti

Mo.	Day	Est.	Obs.
2	9	8.6	Bu

022813
U Ceti

Mo.	Day	Est.	Obs.
2	3	7.7	R
	4	7.6	R
	5	7.5	R
	6	7.5	R
	7	7.4	R
	9	7.7	Bu
	13	7.6	R

023133
R Triang.

Mo.	Day	Est.	Obs.
2	4	11.2	B
	19	10.9	Hu
	19	11.0	Y
	20	11.5	Ba

024356
W Persei

Mo.	Day	Est.	Obs.
2	3	10.0	R
	4	10.3	R
	5	10.4	R
	6	10.1	R
	7	10.0	R

W Persei

Mo.	Day	Est.	Obs.
2	7	9.8	Hy
	10	10.0	Ly
	12	10.4	Pi
	13	10.3	R
	14	9.8	Hy
	15	10.1	Ly
	17	10.1	Pi
	18	9.8	O
	21	9.7	Hy
	22	9.9	Ly
	28	9.1	Ba

030514
U Arietis

Mo.	Day	Est.	Obs.
2	9	9.0	Bu
3	4	7.7	Y

031401
X Ceti

Mo.	Day	Est.	Obs.
2	4	8.9	Hr
	16	10.0	Hr
	23	12.5	Hr

032043
Y Persei

Mo.	Day	Est.	Obs.
2	3	9.2	R
	4	9.3	R
	5	9.2	R
	6	9.2	R
	7	9.2	R
	7	8.7	Hy
	7	8.9	Ly
	9	9.4	Bu
	13	9.1	R
	14	9.0	Hy
	15	9.1	Ly
	17	9.3	Ly
	17	8.6	B
	19	8.1	Hu
	20	8.6	Ba
	21	8.7	Hy
	22	9.5	Ly
	28	8.6	Ba

032335
R Persei

Mo.	Day	Est.	Obs.
2	4	10.2	S
	9	9.8	Bu
	19	8.8	Y
	20	8.6	Ba
	28	8.6	Ba
3	4	8.8	Y
	9	8.4	O

033362
U Camelop.

Mo.	Day	Est.	Obs.
2	3	8.7	R
	4	8.9	R
	5	8.7	R
	6	8.7	R
	7	8.6	R
	9	9.2	Bu
	13	8.7	R
	28	7.2	Ba

VARIABLE STAR OBSERVATIONS Feb.-Mar., 1915—Continued.

035727
RW Tauri

Mo.	Day	Est.	Obs.	
2	20.5	8.3	Ba	

035915
V Eridani

Mo.	Day	Est.	Obs.	
2	3	8.7	R	
	4	8.6	R	
	5	8.8	R	
	6	8.8	R	
	7	8.6	Hy	
	7	8.7	R	
	9	8.8	Bu	
	13	8.7	R	
	14	8.7	Hy	
	18	8.2	Pi	
	21	8.8	Hy	

042209
R Tauri

Mo.	Day	Est.	Obs.	
2	20	11.9	Hu	

042215
W Tauri

Mo.	Day	Est.	Obs.	
2	4	12.4	B	
	10	12.1	Y	
	15	12.0	Ly	
	19	12.3	B	
	20	12.4	Ba	

042309
S Tauri

Mo.	Day	Est.	Obs.	
2	20	11.3	Hu	

043208
RX Tauri

Mo.	Day	Est.	Obs.	
2	3	9.8	R	
	4	10.0	R	
	4	10.1	B	
	5	10.5	R	
	6	10.6	R	
	7	10.5	R	
	9	9.5	Bu	
	12	10.6	O	
	13	10.6	R	
	18	11.0	O	
	19	10.4	B	
	20	11.0	Ba	

043274
X Camelop.

Mo.	Day	Est.	Obs.	
1	12	7.4	L	
2	3	8.5	R	
	4	8.5	R	
	5	8.5	R	
	6	8.4	R	
	7	8.4	R	
	7	8.1	Ly	
	9	8.4	Bu	
	10	8.4	O	
	12	8.3	O	
	13	8.6	R	

X Camelop.

Mo.	Day	Est.	Obs.	
2	13	8.4	Ly	
	15	8.8	Ly	
	16	8.6	Hr	
	17	8.8	O	
	17	8.2	B	
	18	8.9	O	
	20	8.5	Ba	
	20	8.8	O	
3	4	9.8	Y	
	8	10.4	O	

044617
V Tauri

Mo.	Day	Est.	Obs.	
2	4	9.5	B	
	7	9.9	R	
	10	10.1	O	
	13	9.7	R	
	18	10.2	O	
	19	10.0	B	
	19	9.6	Y	
	20	10.1	Ba	

045307
R Orionis

Mo.	Day	Est.	Obs.	
2	10	12.1	Y	
	13	10.9	O	
	20	10.1	Ba	
3	9	10.0	O	

045514
R Leporis

Mo.	Day	Est.	Obs.	
1	10	9.3	L	
2	5	9.7	R	
	6	9.4	R	
	7	9.2	R	
	9	9.2	Bu	
	13	9.4	R	
	16	9.7	Ly	
	18	9.3	Pi	
	20	8.4	Ba	

050022
T Leporis

Mo.	Day	Est.	Obs.	
2	3	10.2	R	
	4	9.8	R	
	5	9.8	R	
	6	9.9	R	
	7	10.0	Hy	
	7	10.1	R	
	9	9.4	Bu	
	13	10.1	R	
	14	10.0	Hy	
	18	10.3	Pi	
	21	9.8	Hy	
	22	10.0	Hy	

050003
V Orionis

Mo.	Day	Est.	Obs.	
2	13	11.2	O	
	17	11.2	B	
	18	11.5	Pi	
	20	11.8	Ba	
3	4	10.6	Y	

050953
R Aurigae

Mo.	Day	Est.	Obs.	
2	3	9.3	R	
	4	9.4	R	
	5	9.5	R	
	6	9.5	R	
	7	9.5	R	
	13	9.5	R	
	20	9.0	Ba	

052036
W Aurigae

Mo.	Day	Est.	Obs.	
2	3	11.5	R	
	4	11.6	R	
	5	11.5	R	
	6	11.4	R	
	7	11.5	R	
	13	11.5	R	

052034
S Aurigæ

Mo.	Day	Est.	Obs.	
2	20	8.1	Ba	
	27	8.6	M	
3	4	8.4	Y	

052404
S Orionis

Mo.	Day	Est.	Obs.	
2	13	10.0	Bu	
	28	10.2	Ba	

053068
S Camelop.

Mo.	Day	Est.	Obs.	
3	4	9.3	Y	

*053005*a
T Orionis

Mo.	Day	Est.	Obs.	
2	7	10.5	Ly	
	8	9.7	Pi	
	9	11.2	M	
	10	10.1	B	
	12	10.4	Ly	
	13	9.8	Bu	
	17	9.8	Pi	
	28	10.5	Ba	

054319
SU Tauri

Mo.	Day	Est.	Obs.	
2	10	9.7	Y	

054615
RU Tauri

Mo.	Day	Est.	Obs.	
2	19	12.7	Y	

054920
U Orionis

Mo.	Day	Est.	Obs.	
2	12	10.7	Ly	
	17	10.4	O	
	18	10.6	Pi	
	19	10.0	Hu	
	21	9.8	M	
	28	9.8	Ba	
3	9	9.4	O	

055353
Z Aurigae

Mo.	Day	Est.	Obs.	
3	4	10.8	Y	

060124
S Leporis

Mo.	Day	Est.	Obs.	
2	3	5.7	R	
	4	6.0	R	
	5	6.1	R	
	7	6.0	R	
	13	6.4	R	

060450
X Aurigae

Mo.	Day	Est.	Obs.	
1	10	8.7	L	
2	13	8.6	Bu	
	14	9.1	V	
	28	10.2	Ba	

060547
SS Aurigae

Mo.	Day	Est.	Obs.	
2	12.5	10.6	Sp	

061702
V Monoc.

Mo.	Day	Est.	Obs.	
2	17	7.2	Pi	

063159
U Lyncis

Mo.	Day	Est.	Obs.	
3	4	12.6	Y	

063558
S Lyncis

Mo.	Day	Est.	Obs.	
2	13	9.9	O	
	13	9.8	Bu	
	18	9.7	O	
	20	9.8	Ba	
3	4	9.5	Y	

064030
X Gemin.

Mo.	Day	Est.	Obs.	
1	10	9.3	L	
2	9	8.6	V	
	10	8.7	O	
	13	8.6	Bu	
	17	8.5	O	

064932
Nova Gemin.

Mo.	Day	Est.	Obs.	
1	10	12.2	L	

065208
X Monoc.

Mo.	Day	Est.	Obs.	
1	10	7.1	L	
2.	3	7.9	R	
	4	7.9	R	
	5	7.8	R	
	6	7.8	R	
	7	7.8	R	
	13	7.8	Bu	
	13	8.0	R	
	14	8.7	Ma	
	17	8.4	Pi	
	17	8.5	L	
	21	8.4	Hy	
	22	8.3	Hy	

065355
R Lyncis

Mo.	Day	Est.	Obs.	
2	6	8.9	R	
	7	9.1	R	
	13	8.6	R	
	13	8.6	O	
	13	8.4	Bu	
	16	8.5	Ly	
	18	8.3	O	
3	4	8.0	Y	

065844
TW Gemin.

Mo.	Day	Est.	Obs.	
2	14	8.2	Hy	
	21	8.1	Hy	

065820
ζ Gemin.

Mo.	Day	Est.	Obs.	
2	3.7	3.9	R	
	4.6	4.1	R	
	5.6	3.9	R	
	6.6	3.7	R	
	7.6	3.8	R	
	13.6	3.9	R	

070122a
R Gemin.

Mo.	Day	Est.	Obs.	
2	3	10.6	R	
	3	10.6	Ly	
	4	10.6	R	
	4	11.4	M	
	4	10.1	B	
	5	10.2	R	
	6	10.3	R	
	7	10.6	R	
	8	10.7	Ly	
	13	10.5	R	
	19	11.4	Sp	
	19	11.0	Hu	
	21	11.0	Hy	

070310
R Can. Min.

Mo.	Day	Est.	Obs.	
1	10	9.5	L	
2	8	9.9	B	
	13	10.7	O	
	16	10.7	M	

071713
V Gemin.

Mo.	Day	Est.	Obs.	
2	20	12.3	Y	

072708
S Can. Min.

Mo.	Day	Est.	Obs.	
1	10	7.0	L	
2	3	7.5	R	
	4	6.7	B	
	4	7.4	S	
	4	7.4	M	
	4	7.4	R	
	5	7.2	R	
	6	7.1	R	
	7	7.2	Hy	
	7	7.1	R	

VARIABLE STAR OBSERVATIONS Feb.-Mar., 1915—Continued.

072708
S Can. Min.

Mo.	Day	Est.	Obs.
2	7	7.5	Ly
	9	7.4	Ma
	9	7.6	M
	11	7.7	O
	13	7.8	Bu
	13	7.2	R
	13	7.8	O
	14	7.8	Hy
	14	7.6	Ma
	14	8.0	St
	16	7.8	M
	16	7.6	Ly
	17	7.8	L
	17	7.8	Pi
	17	7.8	O
	18	7.4	B
	20	7.7	Ma
	20	7.9	O
	21	7.9	Hy
	21	7.9	M
	22	7.9	Ly
	22	7.5	Hy
3	8	8.5	O

072811
T Can. Min.

2	4	9.6	B
	10	10.1	V
	13	10.4	O
	13	10.3	O
	17	10.3	O
	18	10.4	B
	19	10.9	O
	20	10.6	Y

073508
U Can. Min.

1	10	9.5	L
2	4	9.5	B
	10	10.3	M
	10	10.4	O
	13	10.4	O
	13	10.4	Bu
	18	9.8	B

073723
S Gemin.

2	13	12.7	Y
	17	13.1	B

074323
T Gemin.

2	8	9.3	Ly
	10	8.5	V
	12	9.6	Ly
	12	9.1	O
	13	8.6	R
	13	9.8	Bu
	14	9.3	Hy
	17	9.3	O
	20	8.9	Hu
	20	9.5	O
	20	9.3	Y
	21	9.6	Hy
3	9	10.0	O

074922
U Gemin.

Mo.	Day	Est.	Obs.
2	4	13.8	B
	12	11.1	Hy
	16	11.6	M
	18.5	11.7	Pi
3	8.5	10.0	O
	9.5	10.6	O

081112
R Cancri

2	4	10.4	R
	5	10.1	R
	6	10.4	R
	7	10.3	R
	13	9.8	O
	13	10.3	R
	16	9.8	M
	17	9.9	L

081617
V Cancri

2	13	11.2	O
	16	11.5	M
	19	11.2	Pi

081733
T Lyncis

2	16	9.2	M

082405
RT Hydrae

2	8	8.0	B
	17	8.3	L
	19	8.3	O
	19	8.4	Pi
3	8	8.8	O

083019
U Cancri

2	19	13.3	Y

084803
S Hydrae

2	3	8.8	R
	4	8.8	R
	5	8.8	R
	6	8.9	R
	7	9.0	R
	8	10.0	B
	12	9.3	Sp
	13	8.6	R
	13	10.1	O
	13	9.7	Bu
	16	9.8	Hr
	16	9.8	Ly
	16	9.0	Ma
	18	10.1	O
	18	9.6	Sp
	19	9.5	Sp
	20	10.2	Hu
	23	8.8	Hr
3	8	8.6	O

085008
T Hydrae

2	14	8.2	Ma

085120
T Cancri

2	17	10.4	L
	19	9.5	O
	20	9.3	Hu

090425
W Cancri

2	8	13.5	B

093014
X Hydrae

2	20	11.3	Y

093178
Y Draconis

2	13	13.2	Y

093934
R Leo. Min.

2	4	8.3	S
	4	7.1	M
	5	7.8	R
	6	7.7	R
	7	7.8	Hy
	7	7.8	R
	8	7.6	Ly
	13	7.8	R
	13	9.8	Bu
	16	8.6	E
	16	8.1	Ly
	16	7.6	M
	17	7.9	Pi
	19	8.2	O
	20	8.0	Hu
	21	7.7	Hy
	22	8.0	Ly
	22	7.8	Hy
3	8	8.8	O

094211
R Leonis

1	12	6.1	L
2	3	6.2	R
	4	6.2	R
	4	7.2	S
	4	7.1	M
	4	6.9	B
	5	6.1	R
	6	6.1	R
	7	6.0	R
	7	7.3	Hy
	8	6.7	Ly
	9	7.8	Ma
	13	6.9	O
	13	6.1	R
	14	7.8	Ma
	14	7.3	St
	16	7.6	M
	16	6.9	Ly
	16	7.9	E

R Leonis

Mo.	Day	Est.	Obs.
2	17	6.7	L
	18	6.9	O
	18	6.8	Pi
	18	7.3	B
	20	7.9	Ma
	21	7.5	Hy
	22	7.1	Ly
	22	7.5	Hy
3	8	7.2	O

095421
V Leonis

2	4	9.2	B
	4	9.3	M
	10	9.0	V
	16	8.6	M
	18	8.5	O
	18	8.5	B
	19	8.8	Y
3	8	8.5	O

103212
U Hydrae

1	12	5.1	L

103769
R Urs. Maj.

2	3	8.2	Ly
	4	7.5	R
	4	7.6	M
	4	7.8	S
	5	7.4	R
	6	7.2	R
	7	7.2	R
	8	7.5	Pi
	8	7.7	Ly
	9	7.0	M
	9	7.5	Ma
	10	7.7	O
	10	7.0	B
	12	6.6	Sp
	12	7.5	Ly
	13	7.0	R
	13	7.3	O
	14	7.2	Ma
	14	7.5	Ly
	14	6.5	St
	16	7.2	M
	16	7.2	Ly
	17	7.4	O
	17	7.1	M
	18	7.0	Pi
	18	6.6	Sp
	20	7.3	Ba
	20	7.0	Ma
	20	7.0	O
	21	7.0	Hy
	22	7.4	Ly
	22	6.8	Hy
	27	7.0	M
3	4	7.6	S
	8	7.2	O

104620
V Hydrae

Mo.	Day	Est.	Obs.
1	12	6.7	L

104814
W Leonis

2	4	13.1	B
	10	12.8	Y

115919
R Comae

2	14	7.9	R

120012
SU Virginis

2	18	9.3	M

121418
R Corvi

2	14	9.8	R

123160
T Urs. Maj.

2	4	8.5	R
	4	8.0	M
	4	8.2	S
	5	8.4	R
	6	8.5	R
	7	8.5	R
	8	7.8	Ly
	9	8.1	M
	10	8.5	B
	12	8.6	Ly
	12	8.4	Sp
	13	8.6	R
	14	8.6	Ly
	16	8.8	Ma
	16	9.0	E
	'6	8.2	M
	17	8.8	Pi
	17	8.4	M
	18	9.1	O
	18	9.0	Sp
	18	8.8	Pi
	19	8.5	M
	19	9.0	Sp
	20	9.0	Ba
	22	9.0	Ly
	27	9.0	M
3	4	9.6	S

123307
R Virginis

1	12	10.8	L
2	18	10.7	M
	19	9.7	Sp

123459
RS Urs. Maj.

2	17	11.3	M
	20	11.6	Ba

VARIABLE STAR OBSERVATIONS Feb.-Mar., 1915—Continued.

123961
S Urs. Maj.

Mo.	Day	Est.	Obs.
2	8	10.9	Ly
	10	11.5	B
	12	11.2	Sp
	17	11.0	Pi
	17	11.5	M
	18	11.3	Sp
	19	11.4	Sp
	20	11.3	Ba

124606
U Virginis

1	12	9.3	L
2	18	7.8	M

132422
R Hydrae

1	12	7.0	L

132706
S Virginis

12	27	5.8	L
1	12	6.0	L
2	14	8.1	R
	18	7.6	M

134440
R Can. Ven.

2	7	8.0	Ly
	10	8.2	M
	12	7.8	Ly
	16	8.0	M
	16	8.1	E
	17	7.7	B
	19	7.8	M
	28	7.5	M

141567
U Urs. Min.

2	3	8.3	Ly
	4	8.9	S
	6	9.0	R
	7	8.9	R
	10	8.1	Ly
	12	8.8	B
	13	8.8	R
	14	8.0	Ly
	17	8.3	M
3	4	8.6	S

141954
S Boötis

2	14	7.6	R
	14	9.9	Ly
	17	10.1	L
	17	10.3	M
	18	9.7	Pi

142539
V Boötis

2	10	7.8	M
	17	7.6	L
	18	7.5	Sp
	18	7.5	Pi
	19	7.5	M
	19	7.4	Sp

142584
R Camelop.

Mo.	Day	Est.	Obs.
12	27	8.2	L
1	12	8.9	L
2	7	10.4	Ly
	9	10.3	O
	12	10.6	B
	14	11.1	Ly
	17	11.0	O

143227
R Boötis

1	12	12.3	L
2	17	9.2	L
	18	9.2	M
	19	9.2	M

144918
U Boötis

2	18	10.2	M

151520
S Librae

1	12	8.6	L

151731
S Cor. Bor.

2	14	6.6	R
	18	6.8	M

151822
RS Librae

1	12	9.3	L

153378
S Urs. Min.

1	12	12.2	L
2	10	10.5	B
	14	11.1	Ly
	17	11.4	L
	18	10.7	Sp
	20	10.8	Sp

154428
R Cor. Bor.

12	27	6.0	O
1	12	6.0	L
2	14.1	6.4	R
	17	6.0	L
	18.9	6.1	E
	18.8	6.5	M

162119
U Herculis

2	18	10.8	M

162807
SS Herculis

1	12	9.6	L

163137
W Herculis

2	10	10.1	B
	18	10.5	M

163172
R Urs. Min.

Mo.	Day	Est.	Obs.
2	14	10.4	Ly
	18.7	10.5	M

163266
R Draconis

2	14	9.9	Ly
	18	10.1	M
	18	10.3	Sp
	20	10.4	Sp

164055
S Draconis

2	18	9.0	M

164715
S Herculis

2	18	11.4	M

165631
RV Herculis

2	11	10.8	M
	18	11.4	M
	20	11.9	Sp

172809
RU Ophiuchi

2	18	12.0	M

175458
T Draconis

2	20	11.2	Sp

181136
W Lyrae

2	14	8.5	R
	18	8.2	M

184633
***β* Lyrae**

2	14.1	3.7	R

190108
R Aquilae

12	27	7.2	L

190926
X Lyrae

2	14	9.7	R

193732
TT Cygni

12	23	8.0	L
2	14	8.3	R
	17	8.3	L

194048
RT Cygni

2	11	9.7	M

194632
***χ* Cygni**

11	23	4.9	L
1	12	5.0	L
2	14	6.9	R
	17	7.5	L

200647
SV Cygni

Mo.	Day	Est.	Obs.
2	14	9.5	R

200938
RS Cygni

12	23	8.6	L

201647
U Cygni

2	14	9.7	R

202539
RW Cygni

2	11	8.2	M

202946
SZ Cygni

2	4	9.7	R
	5	9.8	R
	6	9.7	R
	7	9.2	R
	14	9.7	R

210868
T Cephei

12	27	6.5	L
1	12	6.8	L
2	4	8.2	O
	7	8.3	Ly
	10	8.0	B
	17	8.5	L
	18	6.7	M

213244
W Cygni

12	23	5.5	L
	27	5.4	L
1	10	5.5	L
2	5	6.3	R
	6	6.4	R
	7	6.4	R
	17	6.1	L

213678
S Cephei

2	10	9.1	B
	18	10.4	M

213843
SS Cygni

12	27	8.6	L
1	10	10.0	L
2	3.5	11.8	Ly
	4.5	12.0	B
	9.5	11.9	Ly
	10.5	11.9	B
	10.5	11.7	Ly
	12.5	11.9	B
	17.5	12.0	B
	18.9	11.7	E
	18.5	11.9	B
	19.5	11.9	B

213937
RV Cygni

Mo.	Day	Est.	Obs.
12	27	7.9	L

222349
S Lacertae

2	19	8.6	Y

222557
δ Cephei

2	3.6	4.1	R
	4.6	4.3	R
	5.6	3.8	R
	6.6	3.9	R
	7.6	4.0	R
	13.6	4.1	R
	14.1	4.2	R

223841
R Lacertae

2	19	8.2	Y

230110
R Pegasi

2	4	9.6	R
	5	9.7	R
	6	9.8	R
	7	9.6	R
	13	9.8	R

230759
V Cassiop.

2	6	9.5	R
	7	9.9	R
	8	9.3	B
	13	9.6	R
	17	9.1	Ly
	19	8.5	B

233335
ST Androm.

2	12	11.4	B

235350
R Cassiop.

2	12	9.0	B
	13	9.6	O
	19	9.6	O
	19	9.5	B

235525
Z Pegasi

2	8	8.0	V

235939
SV Androm.

2	12	12.9	B

No. of observations 846; No. of stars observed 149; No. of observers 20.

The "Companion to the Observatory" cites the following dates of calculated maxima:

001909	S Ceti	Mar. 1	030514	U Arietis	Mar. 4
015354	U Persei	Feb. 23	090425	W Cancri	Feb. 11
021024	R Arietis	Mar. 28	134440	R Can. Ven	Mar. 24
022813	U Ceti	Mar. 23	230759	V Cassiop.	Mar. 25

It is possible that the writer will be obliged to give up his secretaryship temporarily in the near future, as absence from home will prevent a continuance of the work. However, some member will surely volunteer to carry on the reports for a time at least, as we are united in our desire to perpetuate in the clearing house, a feature which, though lacking in scientific value is still of considerable importance in welding together our organization and conserving its best interest.

The secretary feels that whoever takes up his work will have the hearty support of each and every member. To lighten the work of the secretary it is suggested that no letters acknowledging the receipt of lists be required by members. This will save the writing of twenty letters or more.

The following observers contributed to this report:

Messrs. Bancroft, Bouton, Burbeck, Eaton, Harrell, Hay, Hunter, Lacchini, Lindsley, Mach, McAteer, Mundt, Olcott, Pickering, Richter, Spinney, Stepka Vrooman, Miss Swartz, and Miss Young.

WILLIAM TYLER OLCOTT,
Corresponding Sec'y.

Norwich, Conn.
Mar. 10, 1915.

COMMUNICATIONS.

Comet 1915 *a* (Mellish).—I wish to report that I observed Comet 1915 *a* (Mellish) on March 12^d 16^h. The comet was easily picked up with a 4-inch telescope, and while the nucleus is very small, I could see it.

I estimated its position to be α 17^h 45^m δ $0°$ $00'$

Those of our readers who have small telescopes can observe this comet.

DR. WILL CASSELL.

Wytheville, Va., March 13, 1915.

Date of the Picture "Reflections".—In POPULAR ASTRONOMY, for the month (February) there appears a very beautiful photograph indeed, presented to you by Mr. Cooper of New York, showing Halley's Comet, the planet Venus, and the waning moon. No date being given for the taking of this picture amateurs are invited to identify it.

From calculations which I have made, I make the date to be May 6, 1910 and and the hour about 3:30 to 4 A.M.

W. G. C. LANSKAIL.

Montreal, Can. Feb. 22, 1915.

Note on the Visibility of Mercury.—In the last number of POPULAR ASTRONOMY a correspondent mentions having observed the planet Mercury in February at its eastern elongation and suggests that it can seldom be seen at elongations that occur at other times. Lest some amateur should think it useless to look for the planet as evening star in other months, I would like to say that for several years, in connection with the teaching of classes in observational Astronomy, I have watched for the planet at each eastern elongation during the college year, and have records of observations made easily with the naked eye in each month from December to June. When the greatest eastern elongation occurs in the autumn months, September to November, we usually have to find the planet first with telescope or opera glasses (because of its low altitude), and do not see it easily with the naked eye.

According to Mr. Denning,* the greatest brightness of the planet is attained ten or twelve days before its greatest elongation, and the duration of its visibility to the naked eye as seen from Bristol, England, is about $1^h\ 40^m$ in March, $1^h\ 30^m$ in April, $1^h\ 20^m$ in May.

ANNE SEWELL YOUNG.

South Hadley, Mass.

The Quality of the "Seeing" in New Zealand.—I am enclosing a copy of references to observations made by the Eversheds in New Zealand regarding the proposed site for a solar observatory, hoping you may be able to find room for it in POPULAR ASTRONOMY, since it is interesting as showing my work in New Zealand was not "Love's Labour's Lost," but very much worth while.

Kodaikanal Observatory, Bulletin XLII.

Report on the conditions for Astronomical work in Kashmir.

References to New Zealand.

"Mrs. Evershed has had considerable experience of the kind of work in New Zealand, where she had become an expert in estimating the quality of the seeing by projecting the sun's image on a screen."

"Hitherto it has been considered by astronomers that the poor midday definition was inevitable and unavoidable, but careful observations made by us both in Kashmir and New Zealand have proved that this is by no means the case.

"My experience in New Zealand, and at Perth in Western Australia, shows that in calm weather, with a sea breeze blowing, almost perfect definition may be observed at midday near the sea, however hot the air may be, and it was for this reason I selected a site for the Cawthron Observatory on the low hills near the coast at Nelson. Many more imposing sights on the mountains inland were tried, but the definition at high elevations, although better than at Kodaikanal, was found to be far less good than near sea level, and there can be no doubt, from the general purity and blueness of the skies at Nelson, that work of the very highest excellence could be carried out at the site chosen."

It is interesting to note in connection with the above, that while the Eversheds were in Nelson for the purpose of selecting the best possible site for the Cawthron Observatory, a Mr. Jacobson—at one time in charge of the harbour at Nelson, passed through the city, on his way to Auckland. On hearing about the project, he recalled to mind a remark he had heard my father (the late Richard A. Proctor), make in 1880, when leaving Nelson after a course of lectures in that city. As he stood on the deck of the steamer, he looked back at the encircling hills of Nelson

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* See POP. ASTRON., Vol. 8, p. 204.

and remarked, while indicating the Port Hills near the coast, "what an excellent site they would prove for an observatory." Mr. Jacobson's remarks were repeated to Mr. Cawthron, and on the strength of them, he suggested that a trial test should be made at the place indicated. I was rather nervous as to the result, and although I was kindly invited to join the Eversheds on the morning arranged to visit the Port Hills site, I evaded the invitation by making another engagement. Imagine my delight that evening, when I was informed that it was a good site further trials proving that "work of the very highest excellence could be carried out at the site chosen."

MARY PROCTOR.

30 Arkwright Road, Hampstead.
Feb. 4, 1915.

GENERAL NOTES.

Professor John A. Miller, director of the Sproul Observatory of Swarthmore College, has recently been elected vice-president of the college.

Professor W. R. Brooks, for many years in charge of the Observatory at Geneva, N. Y., connected with Smith College, delivered an illustrated lecture before the Providence Y. M. C. A., in their fine new building on Broad St., on Sunday afternoon, February 14, before a large and very much interested audience. The lecture was illustrated with beautiful views, the subject being "The Wonders of the Heavens", and Professor Brooks held the interest of his hearers throughout.

Mr. Samuel H. Tingley, of Providence, R. I. has presented to the Ladd Observatory, connected with Brown University, an instrument for the study of solar prominences. This instrument was made especially to Mr. Tingley's order, in Italian workshops, and is not only costly, but of exquisite workmanship. This will enable those in charge at the Observatory to study prominences without waiting for an eclipse.

Director W. W. Campbell, of the Lick Observatary, president of the American Association for the Advancement of Science, has been elected a foreign member of the Swedish Royal Academy of Sciences, Stockholm, (*Science*, March 5, 1915.)

Dr. T. C. Chamberlin, head of the department of geology in the University of Chicago, and formerly president of the University of Wisconsin, gave a series of lectures in the department of geology of the University of Wisconsin from February 15 to 19, in which he reviewed the Chamberlin-Moulton planetesimal hypothesis of the formation of the solar system, with reference especially to recent work in correlating terrestrial phenomena in the light of this theory. On February 18, Dr. Chamberlin gave a public lecture under the auspicies of the Science Club of the University of Wisconsin on "Early Stages of the Earth's History." (*Science*, March 5, 1915.)

The Lowell Observatory Astronomical Photographs which aroused so much interest during the two months they were exhibited at the Boston Public Library have just been put on exhibition at the American Museum of Natural History in New York.

Professor Armin O. Leuschner, Director of the Students' Observatory in the University of California, delivered a lecture on "Recent Progress in the Study of Motions of Bodies of the Solar System" in California Hall, on the evening of Charter Day, March 23, 1915.

Lille Observatory and the War.—In *The Observatory* for March 1916 is given a very interesting account by Mr. Robert Jonckheere, director of the Observatory at Lille, France, of his tribulations upon the occupation of Lille by the Germans and during his escape to England.

Admission of Women as Fellows of the Royal Astronomical Society.—At the meeting of the Royal Astronomical Society on February 12, 1915 a vote favorable to the admission of women as Fellows and Associates of the Society was adopted 59 to 3, and the Council was requested to take all necessary steps to render their election possible.

The Crèpe Ring of Saturn has been observed and measured at the Lowell Observatory persistently wider on the east than on the west side of the planet during the past month by a difference of five-hundredths. This fact will have important bearings on the mechanics of the stability of the ring. Any phase effect or defect of illumination of the constituents of the ring are not sufficient to explain the phenomenon, on account of the diminutive size of the meteorites composing it. A possible explanation of this detected eccentricity of the ring may be the revolution of its perisaturnium.

German Astronomers and the War.—How the war looks to German astronomers is indicated by the tone of a letter from one of them to an American colleague. With no lack of fervor and patriotism, this astronomer sees the misery of the situation in Europe much as we do. He says that everything is still as sorrowful as in 1914; everyone is in the field in order to defend the poor fatherland. In view of the frightful preponderance of power on the part of the enemies, he can see no end to the struggle. He says: "We often think enviously of your fortunate country, which is not situated in such a lunatic asylum as old Europe is at present."

Photographs of Saturn taken on March 12 at this Observatory both by Mr. E. C. Slipher and the Director confirm visual observations in revealing that Cassini's division is visible in part above the contour of the ball by about four-tenths of its true width. This enables the oblateness of Saturn to be deduced from the photographs, a preliminary reduction of which shows that oblateness to be about one-ninth.

PERCIVAL LOWELL,
Director.

Lowell Observatory,
Flagstaff, Arizona,
March 18, 1915.

Flower Observatory.—Vol. IV, Part 1, of the Publications of this Observatory has come to hand and contains a large number of observations of 1594 double and multiple stars, made by Eric Doolittle with the 18-inch refractor during the years 1904-1912. The measures appear to be very accurate and great pains have been taken with the identification of the stars. The volume is a valuable contribution to the study of the motions of the stars.

Radial Velocities of Nebulae in the Magellanic Clouds.—In the Proceedings of the National Academy of Sciences Vol. 1, No. 3, is a communication by Ralph E. Wilson giving the radial velocities of five nebulæ in the bright southern areas of sky known as the Magellanic Clouds. These are all receding from the sun with remarkably high velocities, one in the Lesser Cloud having a radial velocity of 158 kilometers per second as measured on three spectrograms, and four in the Greater Cloud having an average of 275 kilometers. All these nebulæ have bright line spectra and three lines, Hβ hydrogen, 5007A nebulium and 4959A nebulium, were measured in each case. The spectrograms were taken with a spectrograph especially designed for work on the nebulæ, attached to the 37-inch reflecting telescope of the D. O. Mills Expedition from the Lick Observatory, at Cerro San Cristobal, Santiago, Chile.

"It is difficult to doubt that these nebulæ are actually within the structure of the two Clouds, respectively: N. G. C. 1644, seen upon the Smaller Magellanic Cloud as a background, is the only known bright-line nebula in that region of the sky; and the others are four of the nineteen known bright-line nebulæ closely clustered upon the background of the Greater Magellanic Cloud, which are almost equally isolated from other nebulæ of their kind."

From private letters recently received we learn that others of the nebulæ in the Greater Cloud yield the same average high velocity with the first four, and it would seem that possibly the entire Cloud is receding from us with astonishing speed.

Memorabilia Mathematica.—The Memorabilia Mathematica or the Philomath's Quotation-Book is a name given to a book by Dr. Robert E. Moritz, Professor of Mathematics in the University of Washington. It is a book of 383 pages of quotations. Following the quotations is a large and very useful cross index which enables one to turn quickly to the quotations pertaining to a particular topic. There have been gathered into this volume more than a thousand classical quotations relating to mathematics, from more than three hundred authors. They are grouped into twenty-one chapters, each covering a more or less restricted phase of this extensive subject. In some cases in which the original quotation was not in English the author has given both the original and an English translation.

This book is unique and exceedingly full of interest. Any teacher of college mathematics or even of elementary mathematics will find it very stimulating and suggestive. Because of the long period of time over which this collection extends and of the widely differing peoples from which the quotations are taken, one is impressed by the prominence given to mathematics by all thinking peoples. The book may be opened at any page and the reader finds himself at once in the midst of the most interesting comments by those qualified to speak of the science because of their intimate acquaintance with it. It is highly recommended to any one, teacher or student, who is at all interested in mathematics. It is published by the MacMillan Co., New York, and the price is $3.00.

Actual Time of Signals from the U.S. Naval Observatory, February, 1915.

Day	Time of signals Noon		Time of signals 10:00 p.m.	
	h m s		h m s	
1	11 59 59.89	—.11	9 59 59.89	—.11
2	11 59 59.87	—.13	9 59 59.88	—.12
3	11 59 59.85	—.15	9 59 59.84	—.16
4	11 59 59.82	—.18	9 59 59.81	—.19
5	11 59 59.80	—.20	9 59 59.91	—.09
6	11 59 59.84	—.16	9 59 59.86	—.14
7	11 59 59.84	—.16	9 59 59.84	—.16 Sunday
8	11 59 59.80	—.20	9 59 59.99	—.01
9	11 59 59.99	—.01	10 0 0.00	—.00
10	11 59 59.99	—.01	9 59 59.98	—.02
11	11 59 59.97	—.03	9 59 59.95	—.05
12	11 59 59.95	—.05	9 59 59.94	—.06
13	11 59 59.94	—.06	9 59 59.92	—.08
14	11 59 59.93	—.07	9 59 59.90	—.10 Sunday
15	11 59 59.88	—.12	9 59 59.87	—.13
16	11 59 59.81	—.19	9 59 59.84	—.16
17	11 59 59.85	—.15	9 59 59.97	—.03
18	11 59 59.94	—.06	9 59 59.95	—.05
19	11 59 59.92	—.08	9 59 59.94	—.06
20	11 59 59.91	—.09	10 0 0.02	+.02
21	12 0 0.02	+.02	9 59 59.98	—.02 Sunday
22	11 59 59.99	—.01	10 0 0.00	.00 Holiday
23	11 59 59.98	—.02	9 59 59.97	—.03
24	11 59 59.96	—.04	9 59 59.98	—.02
25	11 59 59.96	—.04	9 59 59.96	—.04
26	11 59 59.96	—.04	9 59 59.97	—.03
27	11 59 59.98	—.02	9 59 59.99	—.01
28	12 0 0.00	.00	10 0 0.01	+.01 Sunday

(+) slow (—) fast

Maximum error: Feb. 5 and 8 —.20.

U. S. Naval Observatory,
Washington, D. C.
March 5, 1915.

J. A. HOOGEWERFF,
Captain U. S. Navy
Superintendent.

Fourteen Stars whose Radial Velocities Vary.—In the *Lick Observatory Bulletin* No. 267, Dr. Ralph E. Wilson gives a list of fourteen southern stars for which variation of the radial velocity has been established by measurement of spectrum plates taken by the D. O. Mills Expedition. They are as follows:

Star	Mag.	Class	α 1900 h m	δ 1900 ° ′	No. of Plates	Range of Velocity
δ *Pictoris*	4.8	B1	6 08.4	—54 56	5	-158^k to -205^k
υ_2 *Puppis*	5.3	B3	7 15.1	—36 34	5	+14 " +40
A.G.C. 9978	5.5	B	7 37.8	—38 18	2	+30 " +98
b Puppis	4.7	B3	7 49.1	—38 36	3	—70 " +38
A.G.C. 10489	5.4	B	7 53.7	—43 14	4	—16 " +82
A.G.C. 11429	5.1	B	8 26.0	—44 23	6	—44 " +74
ζ *Chamaeleontis*	5.2	B	9 36.8	—80 30	3	—64 " —28
θ *Carinae*	3.0	B	10 39.4	—63 52	5	—16 " +58
A.G.C. 15588	5.3	A	11 19.1	—64 24	6	+ 3 " +32
ζ *Centauri*	2.8	B2	13 49.3	—46 47	5	—14 " +80
β *Centauri*	0.8	B1	13 56.7	—59 53	5	—38 " +20
A.G.C. 26980	5.5	A3	19 37.9	—72 45	3	—25 " +20
o Pavonis	5.1	M	21 04.0	—70 32	4	—18 " — 1
A.G.C. 29075	5.3	F	21 06.6	—39 50	4	—50 " + 1